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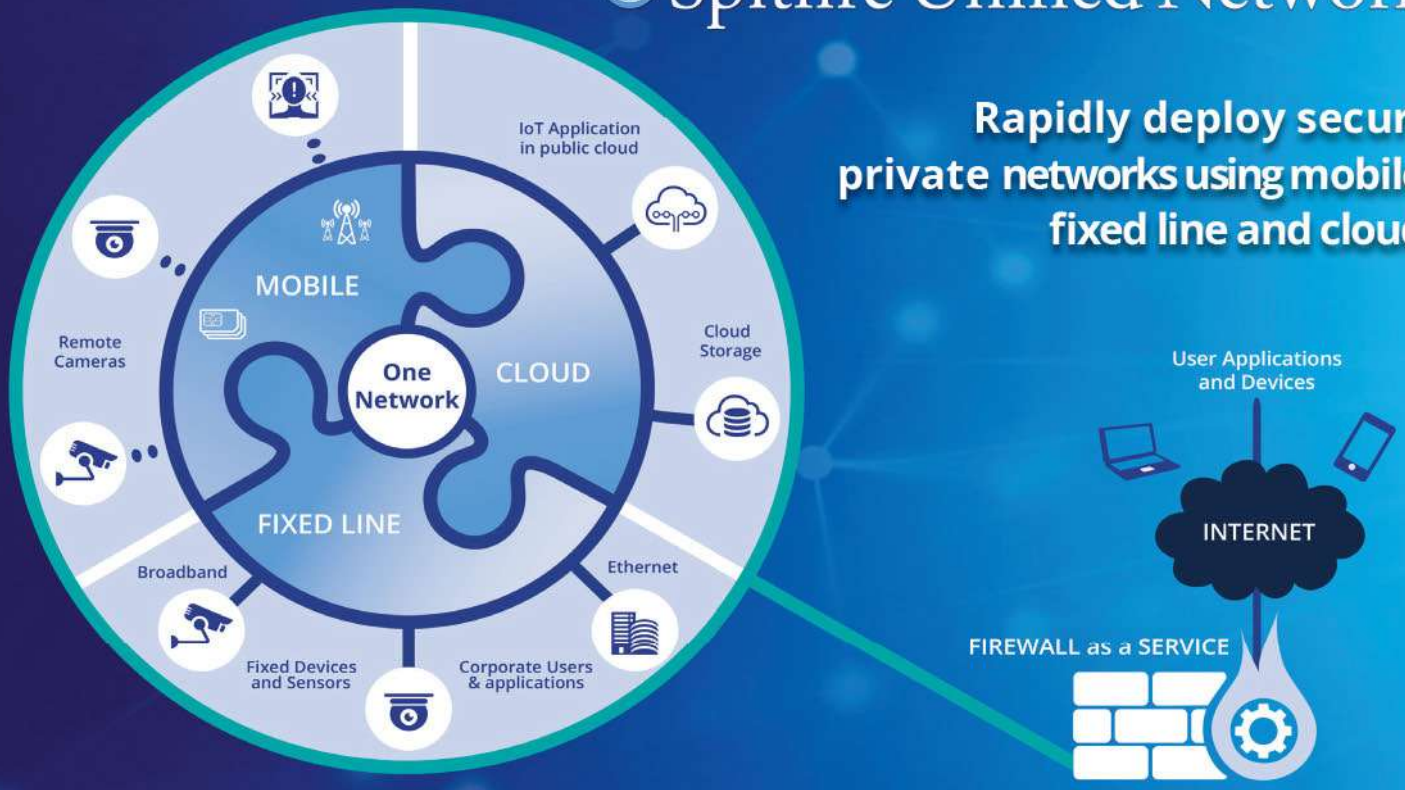

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HIGHLIGHTS THIS MONTH

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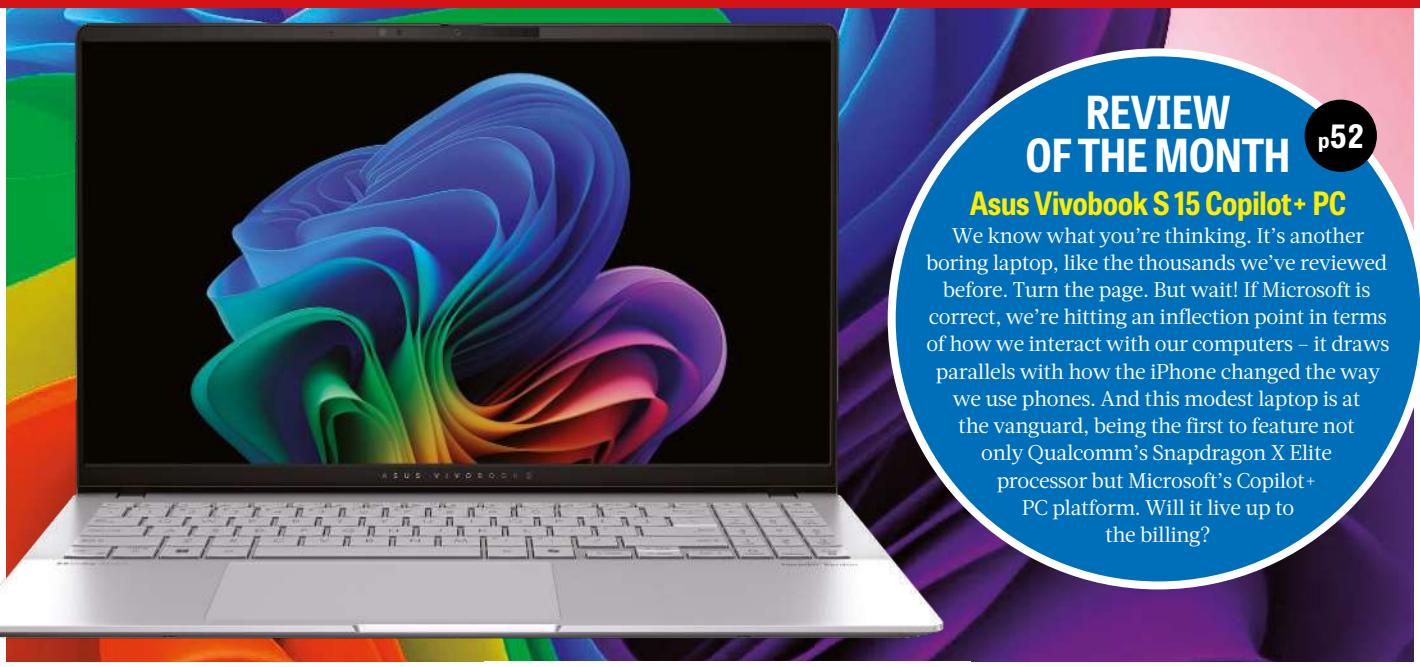


REVIEW OF THE MONTH

p52

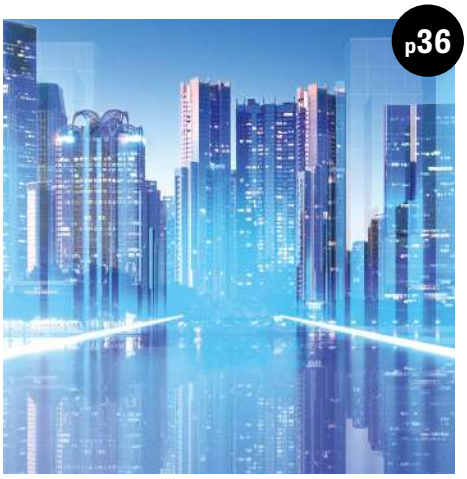
Asus Vivobook S 15 Copilot+ PC

We know what you're thinking. It's another boring laptop, like the thousands we've reviewed before. Turn the page. But wait! If Microsoft is correct, we're hitting an inflection point in terms of how we interact with our computers – it draws parallels with how the iPhone changed the way we use phones. And this modest laptop is at the vanguard, being the first to feature not only Qualcomm's Snapdragon X Elite processor but Microsoft's Copilot+ PC platform. Will it live up to the billing?

p28

PHOTOSHOP SECRETS OF THE MONTH

Adobe is packing Photoshop with AI skills, but it's not always obvious how to make the most of them. Barry Collins reveals all, and explains how to make Photoshop play nicely with Midjourney.



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SMART THINKING OF THE MONTH

Ever wondered why smart cities have never taken off? Nicole Kobie dives deep into the subject this month, as we print an exclusive excerpt from her new book.

p46

PROJECT OF THE MONTH

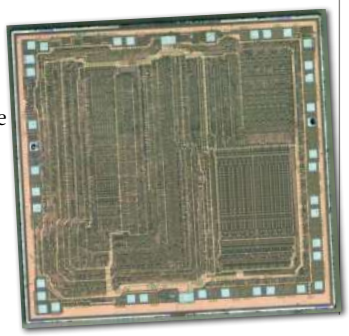
If you're fed up of paying Dropbox, Google and Microsoft a monthly fee for cloud-based storage – or just want to take control of your data – we explain how to run your own cloud server.

CHIP OF THE CENTURY

p123

Zilog Z80

After almost 50 years, the last Zilog Z80 has finally rolled off the production line. We celebrate its amazing story, from its birth in 1976 to its role in the 1980s personal computer revolution, and ask if it still has a future.



THE LABS IN ONE NUMBER

p76

One of the things we love about this month's group test of laptops is the sheer variety on show. With £450 to £1,000 in your pocket, you can buy sleek bargains that last a full day on battery power or gaming showstoppers that include Nvidia's RTX 4060.

p46 **BUILD YOUR OWN "DROPBOX" FOR FREE**

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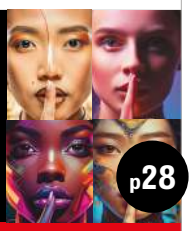

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Real World Computing

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Snapdragon X Elite CPUs are coming to Windows laptops: p110

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REVIEWS THIS MONTH

p63 **HP's latest all-in-one PC is a well-designed, speedy machine with a fine screen – and it's affordable, too**

LABS

EVERYDAY LAPTOPS FROM £450

p76

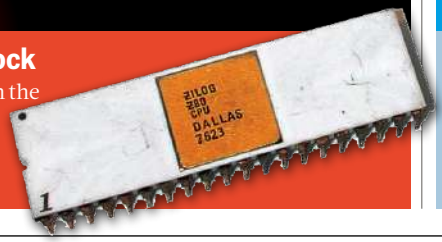
Whether you're looking for a runaround or a racing car, one of these ten tempting Windows laptops will be the perfect choice – plus we compare the Chromebook alternative.

Buyer's guide

96 Cloud backup 2024
Dave Mitchell explains how cloud services can add extra protection to your business data and puts four contenders to the test.

RETRO

123 Chip off the old block
David Crookes looks back on the impact of the Z80 CPU and asks what its future holds now sales have been halted.



Futures

126 Control your computer with your face and head!
We've been trying for years to come up with new ways to interface with computers and nothing is new, especially when it comes to eye tracking and mind control. But if Apple's now on board, maybe its time has finally come, suggests Nicole Kobie.

Put away your cynicism: Copilot+ PCs may actually be good

You know a company is excited about a launch when it tries to position it among the great tech events of history. So, when Microsoft kicked off a 15-minute presentation with an image of a 1981 IBM PC, my hyperbole antennae started quivering.

"In the 80s, we had the IBM PC, which influenced PCs for years to come," announced Sam Hull, senior category manager for Windows Consumer in the UK. "In the 90s we had Windows 95... and Windows launched features at this point that consumers still expect from our ecosystem today, from our OS today."

The third great event was modestly ascribed to Microsoft's rival, with Sam giving a nod to the iPhone. Then last year, we were told, Copilot in Windows changed the way that consumers interact with devices – "and now in 2024 we're rolling into Copilot+ PCs, where you can do a couple of really awesome things that you won't be able to do on any other device."

I won't detail all those awesome things here – I cover them in my review of the Asus Vivobook S 15 OLED (*see p52*). What I will say is that Microsoft might actually be onto something.

Now, for the sake of transparency, I should confess that as I left Microsoft handed me a goody bag that contained a gigantic Copilot-branded mug, a pot of jelly beans and a pen. So I'm a bought man. But I believe that this genuinely is a Big Moment. Not one that should be placed on the same slide as the birth of PCs as we know them, but still.

Why do I say this, other than the sugar high from eating 60g of jelly beans in ten minutes? Because I sense genuine excitement, not merely from Microsoft but from its partners: Acer, Asus, Dell, HP, Lenovo and Samsung are all going big on Copilot+ PCs this year.

Indeed, if you turn to our coverage of Computex 2024 (*see p12*) then you'll see that, even though the first Copilot+ systems are based on Snapdragon chips, AMD and Intel are both fully behind the initiative too. How long has it been since three processor manufacturers have battled it out for a place in our PCs ? I for one welcome Qualcomm into the mainstream fold.

Personally, I'd rank the Copilot+ PC at the same level of importance as when Apple moved to its own silicon – although I can understand why that particular event didn't make it onto Microsoft's slide. We're going to see a shift in expectations on battery life, on power on the move, on fan noise and over the course of time, yes, how people interact with their computers.

But there is one thing that all those great events in technology have in common: their full impact only became clear a year or two after launch. If Microsoft is hoping that everyone still using Windows 10 will now promptly upgrade to a Copilot+ PC then it's in for a shock. Although it should be grateful for our feature on how to keep running Windows 10 forever (*see p42*), which provides a way forward for diehards.

Perhaps the real lesson is to stay focused on the future, rather than the past. We don't yet know whether Copilot+ PCs will go down in history as a triumph or a failure – but at least they're something different. Which reminds me of another marketing campaign from the 1980s.

Tim Danton
Editor-in-chief

In light of our feature on Photoshop's AI secrets (*see p28*), we asked our contributors: what's the most impressive piece of generative AI you've used (or seen) yet?

"Background blur in video calls. Only kidding, but I can't believe that people are still pushing this as one of AI's killer features. The one time I remember being wowed was watching Stable Diffusion in action for the first time. It was on a PC with a kick-ass AMD graphics card – typing in the prompt and seeing results (that you can tweak) in real-time was simply stunning."

"Most impressive I've seen is whatever the hell Petr Valek uses. Most impressive I've used was Stable Diffusion when I asked it to do spoof cookery illustrations."

"Honestly, it's the Remove tool in Photoshop. One click and spots, blemishes and other unwanted image elements are just gone, like they were never there. It's positively eerie."

"Otter.ai's ability to both transcribe audio meetings (even from scratchy audio) and let you ask questions about them has been truly game-changing for my work."

"As we're writing this in election season, there are plenty of convincing but fake political video and pictures doing the rounds. However, the most impressive piece I've yet seen must surely be whichever one was so convincing I didn't realise it was AI, which makes this question impossible to answer."

"Well, I hate to blow my own trumpet, but the finest gen-AI ever wrought appears on p113 of this very issue. I'm braced for a bidding war between the Musei Vaticani and Museo di Arte Sacra to display this visual symphony."

"Plaud Note transcription used in conjunction with the Plaud voice recorder hardware for iPhone. It. Just. Works."

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Briefing

Background and analysis on all the important news stories

Recall rush backfires on Microsoft

Windows AI tool ships to testers with huge security blunder, as Apple takes privacy high ground

Microsoft's rush to embed an all-seeing AI assistant into Windows resulted in the company shipping a product to beta testers that contained huge security flaws, forcing the firm to delay the launch of the flagship feature for the new Copilot+ PCs.

Recall was the big announcement from Microsoft's Build conference in May, with the company keen to further its AI advantage over Apple, which then announced "Apple Intelligence" at WWDC a fortnight later.

Recall was hawked as an AI assistant that would let you "retrace your steps" on your PC, with the AI remembering everything you've done on the system. It does this by taking a screenshot every few seconds, with the information transcribed into a plain text SQLite database.

But as security researchers quickly discovered when Microsoft released test builds of Windows 11 with Recall enabled by default, this database was left unencrypted, making it possible for hackers to remotely break into users' PCs and access it. The database could contain information such as passwords, bank account numbers and other highly sensitive data that the AI has captured.

"Stealing everything you've ever typed or viewed on your own Windows PC is now possible with two lines of code," tweeted Kevin Beaumont, a security researcher who exposed the flaws with the AI.

"I do not believe cybersecurity or privacy people should sit on the fence on this one," he added. "Knowingly shipping features that are implemented so poorly they radically decrease human safety is a rubicon. If this ships, Microsoft Security, regulators and governments have failed."

Microsoft rows back

Thankfully, Recall won't be shipping in the state it was initially offered to Windows Insiders. Microsoft put out an "update" on the Recall preview in June, announcing it would be delaying its launch and making several changes to the system before it shipped.

First, it will now be switched off by default, with owners of the new breed of Copilot+ PCs on which Recall will ship (such as the Asus Vivobook S 15 we review on p52) being shown a screen during setup that gives them the choice of running the feature. If they choose not to switch it on, Recall won't capture any information.

ABOVE Microsoft has been forced to delay the launch of its headline feature

> "Stealing everything you've ever typed or viewed on your own PC is now possible with two lines of code"

Recall users will also now be required to turn on Windows Hello and must authenticate every time they use the feature. Crucially, Microsoft will encrypt the SQLite database that Recall creates, while the captured screenshots (or snapshots as Microsoft calls them) will only be decrypted when the user authenticates.

"Turns out speaking out works," Beaumont tweeted, after Microsoft posted its Recall security update.

Industry analysts don't believe the security blunder will cause any long-term damage for Recall, believing it remains a tempting proposition for both businesses and consumers. "I think when you start to use it... and see how that can help you go back in time and see where you've been, what you've been doing previously, and jump straight back to that given point in time, that's got utility, whether you're a consumer or an enterprise," said Geoff Blaber, CEO of CCS Insight.

Apple Intelligence

With the Recall security fiasco still fresh in the memory, Apple used this year's WWDC to reveal its AI plans.

Ever-keen on the privacy high ground, Apple announced that its own AI system – which will work across iOS, iPadOS and macOS – would put a strong emphasis on protecting users' data. It has more modest ambitions than Recall, focusing on specific tasks rather than becoming an all-seeing memory bank.

Apple Intelligence will, for example, scan users' Mail inboxes and prioritise messages it deems to be most relevant, such as a boarding pass for a flight later that day or a same-day dinner invitation from a friend. Notifications will get similar treatment, with so-called Priority Notifications floating to the top of the stack, and a new Reduce Interruptions mode that surfaces only those notifications that require urgent attention.

> "Apple insists that even it can't access the data being sent to the cloud for processing"

The much-lambasted Siri is also given an AI upgrade, with Apple claiming the assistant will now understand a much wider set of commands, and can guide users on how to access different Mac functions, much like Windows Copilot.

Unlike Recall, Apple won't do all its AI processing locally, prompting the company to take the extraordinary step of creating "Private Cloud Compute" for each user, with Apple insisting even it can't access the data being sent to the cloud for processing.

"Anyone who's got any awareness of generative AI will have some awareness of issues around privacy," said Blaber. "Microsoft is taking an on-device approach with Copilot+ and pointing out privacy in that respect. Apple hasn't done that entirely, because there's just certain limitations in terms of what it can do today that's purely on-device. The next best thing is to say it's all contained within an Apple cloud."

However, Apple appeared to tacitly admit its own AI effort won't be quite as sophisticated as that of third-party offerings, offering support for ChatGPT on its phones, tablets and computers in addition to Apple Intelligence. However, users who invoke ChatGPT on Apple devices are likely to face regular permissions pop-ups to ensure they want to send personal data to ChatGPT or other third-party AI services that Apple plans to support.

Analysts wonder if consumers might tire of the nagging. "Apple's integration of ChatGPT is very interesting," said Tom Mainelli, group vice president at IDC. "Will users appreciate being asked if they want to share their data with the cloud-based service, or will they tire of the repeated ask?"

Now ePaper's coming after posters

Super-sized displays designed to replace paper prints

New ePaper displays up to an enormous 25in in size are being touted as a low-maintenance replacement for posters and signage in commercial venues.

The Sharp NEC ePaper Displays come in two sizes – 25.3in and 13.3in – offering full colour resolutions of 3,200 x 1,800 and 1,600 x 1,200 respectively. The displays share many of the same qualities as paper: a viewing angle of 180°, easily visible in bright environments and always on. In fact, they need power only when refreshing the content of the screen.

"These need to be put in well-lit areas and treated like paper," Jack Wilders, senior solutions architect at Sharp NEC Display Solutions told *PC Pro*. "Users have to think about which colours are going to pop on it. It's definitely more similar to paper [than screens]."

The big advantage ePaper displays have over paper is that the content of the display can be changed remotely, with none of the costs of printing or sending someone to change the signage. They're being touted for use in venues such as hotels, where signage from conference rooms changes frequently, or cafés and restaurants where menu changes can be updated.

"The displays are replacing existing print, but still have the benefit of being able to dynamically change it," Wilders said. "Lot of screens at the moment are just burning energy for static content."

The displays aren't suitable for real-time information updates, such as airport or train departure displays, because of the relatively tardy 30-90 seconds it takes to refresh the display.

The technology works in a similar way to colour printers, with each of the four colours (yellow, cyan, magenta and reflective white particles) effectively passing over the display to form the image.

That means the ePaper can display up to 50,000 colours, and in demonstrations at a London hotel the image on the 25in display looked pin sharp and hard to tell apart from printed materials. The image quality is even good enough to display art.

Once the image is created, it stays on screen without any power required for up to two years, although Wilders said it might start to fade after 18 months. The displays can be powered from the mains or fitted with battery packs to provide power when they need updating.

The screens can be updated via a USB stick or wirelessly via Bluetooth or Wi-Fi, and Sharp NEC is working with several commercial content providers. The 25in display has an MSRP of £1,364 exc VAT, with the 13in display costing £880 exc VAT.

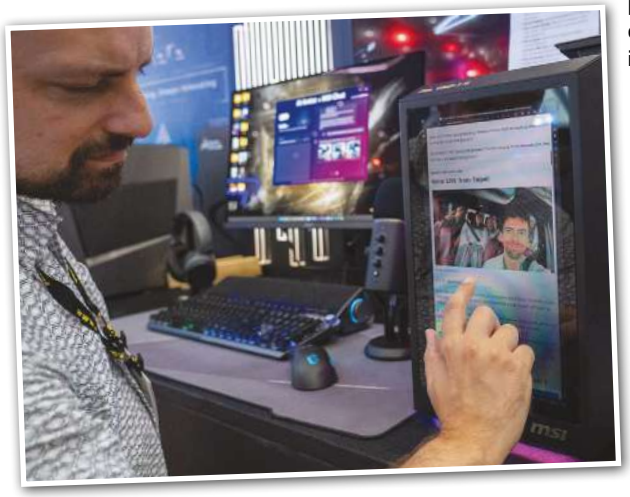
BELOW Content on the new ePaper displays can be changed remotely

Best of Computex 2024

From new Intel and AMD CPUs to a trio of handheld PCs, here are our top picks from a packed Computex 2024

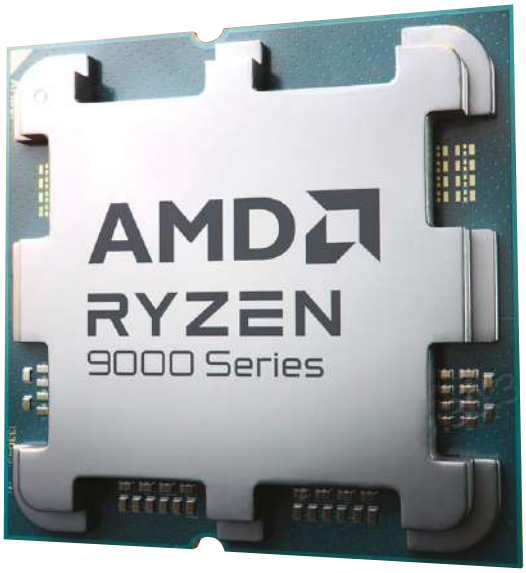
MSI brings AI PCs to the desktop

MSI unveiled the **MEG Vision X AI**, promising to bring AI PC features to desktop users via MSI's proprietary AI Engine – complete with a touchscreen AI human-machine interface (HMI). This touchscreen sits at the front of the PC, supposedly giving users easy access to the PC's onboard AI. So you can produce high-quality images via MSI Artist x MSI Chat, perform text generation, ask questions and summarise documents without an internet connection or using that fiddly keyboard.



AMD brings Zen 5 to CPUs and new hope to upgraders

In AMD's keynote presentation the company announced its **Ryzen 9000 processors** based on its Zen 5 architecture, which it promises will have a 16% boost over Zen 4. It revealed four initial chips, with the 16-core **Ryzen 9 9950X** leading the charge. AMD also announced two new AM5 motherboard chipsets, **X870** and **X870E**, with support for USB 4 and PCI-E Gen5, adding that Ryzen 8000 and Ryzen 7000 CPUs will also be compatible with the new boards. And AMD has good news for all upgraders, with its new **Ryzen 9 5900XT** and **Ryzen 7 5800XT** keeping upgrade options open for AM4 motherboard owners. All the new products will be available from July.



A trio of handheld PCs

After our feature on handheld PCs last month (*see issue 358, p34*), we got our hands on the upgraded **Asus ROG Ally X** with its 80Wh battery and greatly improved joystick and buttons (plus the base storage starts at 1TB). You can pre-order it now from **uk.store.asus.com** for £799. MSI also announced the **MSI Claw 8 AI Plus**, featuring Intel's Lunar Lake chips, a larger 8in 120Hz screen and (like Asus) a bigger 80Wh battery. Then out of nowhere came the **Zotac Zone** (pictured below), with its Ryzen 7 8840U processor and super-bright 7in 120Hz OLED. Storage starts at 512GB but there's an empty M.2 slot for adding more. The 48.5Wh battery is a concern, however. We await prices and a release date for both the MSI and Zotac devices.

Acer debuts swathe of AI laptops and a cool 3D camera

Okay, Acer, calm down. We counted 18 launches at Computex 2024, most on sale in Q3 2024, so we'll race through our favourites. Top of the list: the €549 **SpatialLabs Eyes** camera that can stream in 3D. Perfect for the SpatialLabs 27 View Pro 3D monitor we reviewed last month (*see issue 358, p68*). We also laid hands on Acer's new AI-toting TravelMate laptops, with the 1.2kg **TravelMate P6 14** the most stylish. Intel's Core Ultra chips provide its AI chops, with prices starting at €1,359. Then there was a new line of Copilot+ PCs, under Acer's **Swift AI** brand, that will be based on AMD's Ryzen AI 300 series (no prices yet). Acer also announced two all-in-one PCs, a trio of Chromebook Plus laptops, three OLED

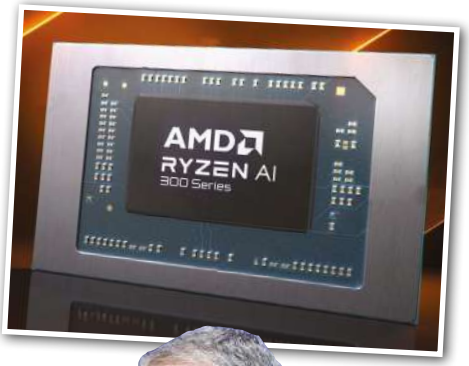
Asus woos creators with ProArt laptops

We're used to praising Asus' ProArt monitors for their colour accuracy and high-end features, but the Taiwanese giant chose Computex to announce a trio of ProArt laptops. The eye-catching **PZ13** takes on the new Surface Pro in both design and specs, with a 13.3in OLED screen and Qualcomm's Snapdragon X Elite chip inside, while the **PX13** and **P16** use AMD's new Ryzen AI 300 processors. The PX13 is a 13in convertible with integrated graphics, but the 16in P16 is a true desktop replacement with up to 64GB of RAM and RTX 4070 graphics. You can pre-order them now, with the PZ13 starting at £1,199, the PC13 from £1,999 and the P16 from £3,499.

gaming monitors, four smart monitors with Google TV built in and a Wi-Fi 7 mesh router. Phew.

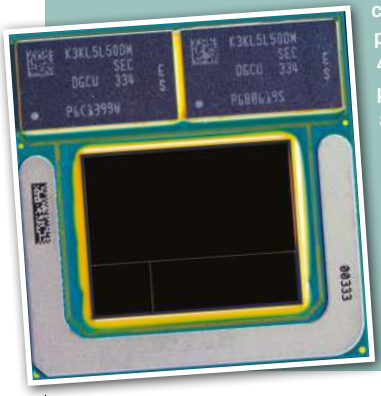
AMD answers Qualcomm with AI mobile chips

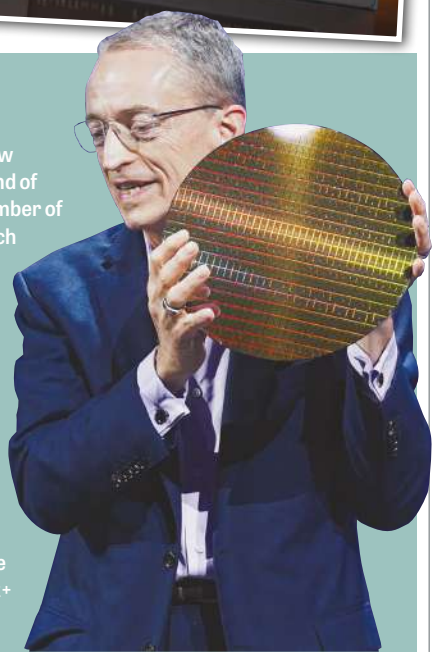
AMD announced two Ryzen AI 300 series mobile processors, claiming that laptops will arrive far sooner than expected – possibly as early as July. The new SoCs will feature the most powerful NPU yet released on a mobile platform, rated at 50 TOPS, which is well north of where they need to be for Microsoft Copilot+. The series launched with the AMD Ryzen AI 9 HX 370 and Ryzen AI 9 365. The former is a 12-core/24-thread processor with Radeon 890M graphics, a maximum boost clock of 5.1GHz and 36MB cache. The Ryzen AI 9 365 features ten cores, 20 threads, a maximum boost clock of 5GHz and 34MB cache.



Intel announces AI-enhanced chips

Intel lifted the curtain on its latest processor series, codenamed **Lunar Lake**, at Computex 2024, with the new chips expected to show up in ultra-thin laptops by the end of 2024. The new system-on-a-chip (SoC) introduces a number of innovations over the current-gen Meteor Lake SoCs such as the Intel Core and Core Ultra processors, with Intel claiming better power efficiency, a 4x increase in NPU processing power, a 50% faster Intel Arc GPU and on-chip memory for a smaller footprint and faster memory access. They will be Intel's first Copilot+ PC processors.





And finally – many, many gaming laptops

Computex wouldn't be Computex without heaps of new gaming laptops, and Asus and MSI didn't disappoint. While dozens were launched at the show, we'll pick out two. First, the **Asus TUF Gaming A14** is a mid-range model with minimal compromises, offering a CNC-milled 1.5kg chassis packing up to RTX 4060 graphics and AMD's new Ryzen AI 9 HX 370 processor. And the 14in OLED screen looks stunning, complete with a 165Hz refresh rate. Then there's the **MSI Stealth A16 AI+**, with the same AMD CPU, up to RTX 4070 graphics and a lovely tactile keyboard – plus a 99.9Wh battery and 16in, 240Hz IPS panel. The downside is its 2.1kg weight. We await prices, but both should be available to buy in the third quarter of 2024.

ON-SITE TEAM: Jason England, Craig Hale, Allisa James, John Loeffler

Who's checking the age checkers?

Websites will soon be forced to check visitors' ages. But as Barry Collins discovers, there are precious few checks on the age-verification services

In the not-too-distant future, we will all need to pass an age-verification test to access a broad swathe of websites. Not only "adult" sites, but social media services, sites associated with violent video games, basically anything that contains content that might be deemed harmful to children.

Queuing up to profit from these government-mandated checks are a whole host of age-verification providers, who will use a variety of methods to assess the age of visitors, including AI tools that estimate someone's age by simply looking at them through their webcam.

But who's verifying the age-verification firms? Who will ensure that the companies collecting this highly sensitive data are doing so securely and with maximum safeguards in place for people's privacy? Who will check that their age-verification methods are even reliable? In short, the answer is nobody.

The era of age verification

The age-verification requirements are part of the wide-sweeping Online Safety Act, which passed through parliament with nary a whisper of opposition last year. As with many of the Act's provisions, the responsibility for implementing the age-verification regime falls on telecoms regulator Ofcom.

Ofcom's draft Children's Safety Codes of Practice, published in May, started to flesh out what website owners will be required to do. "All services which do not ban harmful content, and those at higher risk of it being shared on their service, will be expected to implement highly effective age-checks to prevent children from seeing it," Ofcom's press release on the draft Safety Codes stated.

> "There's not only the cost of implementing age verification, but the lost revenue from customers who are put off by the age checks"

By "highly effective", Ofcom doesn't mean drop-down menus that let you self-declare your date of birth, as found on many adult websites currently. Instead, they will be expected to use age-verification methods that are "technically accurate", "robust", "reliable" and "fair". Ofcom's draft Safety Codes lists several methods that could be regarded as "highly effective", including open banking, photo-ID matching and the aforementioned facial age estimation.

Ofcom makes no bones about the fact that this is going to be a significant burden on website operators. "The [Online Safety] Act is really clear that children require a higher standard of protection than adults," said Jess Smith, a principal with the online safety team at Ofcom. "Checking age is the way to ensure that children are safe."

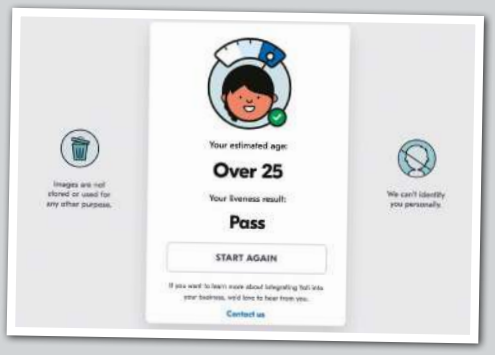
Ofcom's draft code provides detailed cost estimates of implementing third-party age assurance methods, and they're substantial. For a "smaller service" with 100,000 existing users and 10,000 new users each year, Ofcom estimates that age assurance will cost somewhere between £6,000 and £22,000 per year. For a "larger service" with 20 million users and 200,000 new users per year the costs are pegged at between £1 million to £4 million a year. "We expect costs to come down," said Smith. "We expect there to be fairly straightforward

How good are AI age estimates?

We asked both Yoti and VerifyMy if we could test their facial age estimation systems. To be clear, this is far from a scientific test of the systems, more of an anecdotal assessment. We tested with three different people: my almost 14-year-old daughter, my 19-year-old daughter and me, a 46-year-old man. All of us were tested using the webcam on a MacBook Pro.

When it came to guessing the correct age, Yoti's system delivered variable results. It claimed the near 14-year-old was under 13, that my 19-year-old daughter was between 16 and 18 and that I was between 39 and 47, meaning only one of us was placed in the correct age band.

More alarmingly, it claimed that my very much alive 13-year-old had failed the "liveness test", designed to spot when people are trying to trick the system by using a photo or video of someone else. However, when I tried to fool the system by holding a video of myself on an iPad screen up to the camera, it correctly flagged this as not a real person.



We had mixed results in our unscientific tests

VerifyMy provided less granular age bands than Yoti. It confirmed both me and my 19-year-old daughter were over 18, but despite repeated attempts said it was "unable to verify" the age of my 13-year-old. When I attempted to fool it with the video of my face on an iPad screen, it again said it was unable to verify.

ABOVE **Websites with adult content will have to verify the age of users**

ways of checking age in the future, but we are clear that there will be implementation costs to protect children."

There's not only the cost of implementing age verification, but the lost revenue from customers who are put off by the age checks. "Our research suggests that some users may be reluctant to prove their age due to not wanting to share personal information with a service or worries about data privacy," Ofcom's draft code states.

I put it to Smith that with Ofcom enforcing these measures on "even the smallest" of website providers, some legal services will go out of business as a consequence of these measures. "Protecting children will be a cost of doing business on services in the UK the future, yes," she said.

The age checkers

There's certainly no shortage of companies lining up to provide age verification for websites and apps. Yoti is one such provider. It sponsored the UK All-Party Parliamentary Group for Digital Identity and was part of the Home Office Identity Document Working Group, so it's been engaging with politicians on age verification for some time.

The company offers a wide range of methods to verify a user's age, including automated systems that use the NFC chip in smartphones to read a passport's biometric data, just like the electronic gates you get at airports. Other methods include credit card checks, checks with the user's mobile network and checks against other databases that have previously verified the user's date of birth.

However, when presented with a range of options to verify their age, Yoti's chief regulatory and policy officer, Julie Dawson, claims customers normally opt for the AI.

"When several methods are offered side by side, over 80% of consumers are actually picking the facial ageing estimation approach," she said.

How accurate is that? Dawson shares with me a white paper published by the firm that claims for 18-year-olds, its facial age estimations are on average within 1.2 years of the person's real age. If you raise the bar to "challenge 25", where anyone estimated to be younger than 25 is asked for additional ID to prove their age, Yoti claims the accuracy of the system rises to 99.91%. (See the boxout opposite for the results of our tests of Yoti's age estimation system.)

That buffer is critical. Yoti provides the age-verification system for OnlyFans, a site arguably best known for effectively crowdfunding porn stars. OnlyFans is currently under investigation by Ofcom over concerns it's not doing enough to prevent children from accessing pornography, with the regulator specifically stating that "the age assurance measures it had taken may not have been implemented in such a way as to protect under 18s from restricted material".

Dawson said Yoti wasn't party to the discussions between Ofcom and OnlyFans, but hinted that the problem may have boiled down to the site setting too narrow a buffer for age checks using its software. Dawson suggested that Ofcom "may in future state the accuracy level that's a minimum for, say, adult content is a three-year or a five-year buffer", but that "has not been published yet".

Minimum standards

It's not only the accuracy of the age-verification services that is of concern, but the privacy and security of their solutions, too.

Both age-verification providers we spoke to insisted that all personal data, such as ID documents or facial estimation images, were deleted from their systems after the verification check was complete. Both claimed that they provided nothing more than a yes/no answer to the sites they worked with, so that if the site were attacked, there would be no honeypot of identifiable user data waiting to be exploited by, say, blackmailers who threatened to expose the identity of visitors to a porn site.

> "There are currently no specific security or privacy standards that age-verification providers will be required to meet"

However, there are currently no specific security or privacy standards that age-verification providers will be required to meet. Nor will Ofcom provide a list of approved age-verification providers. The onus is very much on the website owners to satisfy themselves of the accuracy and the security of the age-verification services they choose to work with.

Even the age-verification providers themselves believe standards are necessary. "We always advocate for international standards," said Andy Lulham, chief operating officer for age-verification provider VerifyMy.

"Where I have empathy with big tech platforms is if they've got to implement technology A in France that is to this level, and then across the Channel it's a different level, then that becomes complex for them and an unnecessary blocker to being able to do the right thing."

Ofcom insists it's not about to set rigid standards or validate age-verification providers, however. "What we can't do is take the onus off the services," said Smith, referring to the companies running websites or apps. "If they are offering this kind of service to users in the UK, then they are in scope of the regulation and it is incumbent on them to meet those duties and just satisfy themselves that they are meeting those duties."

What could possibly go wrong?

The A-List

PC PRO A-LIST

The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Apple MacBook Pro 16in (2023)

M3 power from £1,699

from apple.com/uk

The M3 chips give the already brilliant MacBook Pro series a boost in games with no sacrifices elsewhere, so power users who are happy with Apple must grapple with the big decisions: which M3 chip, which size of screen, and how much RAM and storage?

REVIEW **Issue 352, p46**

BUSINESS LAPTOPS

Lenovo ThinkPad X1 Carbon Gen 12

Super computer from £1,375 exc VAT

from lenovo.com

The brilliant X1 Carbon range has stepped up a performance gear thanks to Intel's Core Ultra chips, and Lenovo matches it with the stunning build quality and keyboard you'd expect. At 1.1kg, this is a powerhouse ultraportable. Pay the extra for the OLED screen, though.

REVIEW **Issue 358, p58**

ALTERNATIVES

Apple Mac Book Air13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299 from apple.com/uk**

REVIEW **Issue 356, p54**

Huawei MateBook X Pro (2024)

Despite weighing just 980g, this laptop packs a 14.2in OLED panel, 2TB of storage and an 11-hour battery life, as well as an Intel Core Ultra 9 processor. **£2,100 from consumer.huawei.com**

REVIEW **Issue 358, p60**

Asus Vivobook Pro 15 OLED (2024)

A mobile workstation disguised as a slim laptop, the Core i9/RTX 4060 combo provides a staggering amount of power in its high-quality, 1.8kg frame. **£1,600 from uk.store.asus.com**

REVIEW **Issue 357, p60**

Dell Latitude 7340

This 1.1kg laptop offers terrific battery life and, if you choose the better non-touchscreen (look for 400 nits of brightness in the specs) it's a joy to use, too. **From £1,109 exc VAT from dell.co.uk**

REVIEW **Issue 350, p82**

Acer TravelMate P6 (TMP614-53)

The all-new TravelMate P6 benefits from a 14in OLED screen with a 2,880 x 1,800 resolution, plus a very generous spec for the price. It's simply great value. **£1,209 exc VAT from acer.co.uk**

REVIEW **Issue 350, p80**

HP Dragonfly G4

It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives. **From £1,380 exc VAT from hp.com**

REVIEW **Issue 352, p58**

GAMING LAPTOPS

NEW ENTRY

Razer Blade 16 (2024)

Power and panache, from £3,000

from razer.com

The Blade 16 offers a sumptuous OLED screen, bags of connectivity and astonishing levels of performance – particularly with the RTX 4090 in place. If you're in the market for a powerful 16in laptop that will eat up games and creative applications, this is the one to go for.

REVIEW **Issue 359, p60**

EVERYDAY LAPTOPS

NEW ENTRY

Acer Aspire 14 A14-51GM

Compact power for £850

from acer.com

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price.

REVIEW **Issue 359, p82**

ALTERNATIVES

Lenovo Legion 9i Gen 8 (16in Intel)

The liquid-cooling system may be only for bragging rights, but this slim laptop delivers the goods with a superb 16in mini-LED screen. **RTX 4090, £4,180 inc VAT from lenovo.com**

REVIEW **Issue 353, p58**

HP Omen Transcend 14

This compact, stylish 14in OLED gaming laptop packs a punch thanks to its RTX 4060 graphics. **Part code, 9R292EA#ABU. £1,799 from hp.com/uk**

REVIEW **Issue 357, p54**

Asus ROG Zephyrus G14 (2024)

This sleek 1.5kg laptop can take RTX 4070 cards to deliver triple-figure frame rates on its 120Hz 14in OLED screen. **From £2,400 from rog.asus.com**

REVIEW **Issue 356, p58**

NEW ENTRY

Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099 from uk.store.asus.com**

REVIEW **Issue 359, p58**

Microsoft Surface Laptop Go 2

The Laptop Go 2 won our recent group test of affordable laptops thanks to its high-quality 12.5in screen, 1.1kg weight and sleek design. **£555 from microsoft.com**

REVIEW **Issue 347, p89**

NEW ENTRY

Huawei MateBook D16

It's big and certainly not bashful, packing an Intel Core i9 chip and a high-quality 16in panel – and surprisingly good battery life, too. **£1,000 from huawei.com**

REVIEW **Issue 359, p87**

CHROMEBOOKS

Acer Chromebook Spin 714

Flipping great for £799

from currys.co.uk

Simply the best Chromebook around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this convertible for £799.

REVIEW **Issue 356, p83**

Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from currys.co.uk**

REVIEW **Issue 356, p82**

Lenovo IdeaPad 5i Gaming Chromebook Plus

The 120Hz 15.6in display is the star of this Chromebook, as it should be with 2,560 x 1,600 pixels to play with. You're getting a lot of laptop for the price, too, including a 512GB SSD, Core i5-1235U processor and 8GB of RAM. Just note the 1.9kg weight. **£659 from very.co.uk**

REVIEW **Issue 356, p88**

EVERYDAY PCs

NEW ENTRY

Apple Mac mini (2023)

M2 masterpiece from £649

from apple.com/uk

The outside remains the same, but this simple yet effective update to the Mac mini introduces the M2 and M2 Pro processors with predictable effect. The entry-level price quickly rises once you start upgrading – moving from 8GB to 16GB costs £200, as does doubling the base storage from 256GB to 512GB – but there's enough power here to last you for years.

REVIEW **Issue 343, p60**

Geekom A8 Mini PC

Geekom makes brilliant use of AMD's Ryzen 9 8945HS in this powerful mini PC, which occupies little more desktop space than a drinks coaster. And it still packs every port most people need, plus Wi-Fi 6E. If you don't need this much power (or 32GB of RAM and a 2TB SSD) the Ryzen 7 version is £719. **Ryzen 9, £899 from geekom.co.uk**

REVIEW **Issue 359, p62**

PCSpecialist Fusion Elite P

A promising debut for AMD's Ryzen 8600G processor, this quiet-running, power-efficient system packs in lots of performance considering it costs so little. And a slot sits empty for a future graphics card upgrade should the built-in graphics prove insufficient for your gaming needs. **£649 from pcspecialist.co.uk/reviews**

REVIEW **Issue 355, p54**

ENTHUSIAST PCs

Cyberpower Ultra R77 RTX Gaming PC

RTX Super 4080 power for £2,275

from tinyurl.com/356cyber

The striking case catches the eye, but it's the potency of AMD's Ryzen 7 7800X3D and Nvidia's RTX 4080 Super graphics that leave the lasting effect.

REVIEW **Issue 356, p62**

HP Omen 45L (2023)

We tested the top-end 45L with a Core i9-13900K, GeForce RTX 4090 graphics and 64GB of RAM, and it doesn't come cheap. Switch to the Core i7/RTX 4070 Ti version, however, and the price almost halves without losing any of the superb design and build quality. **£4,800 from hp.co.uk**

REVIEW **Issue 347, p50**

Alienware Aurora R16

An understated yet stylish gaming PC that runs quietly even when pushed. This rig has power where it counts, mixing Intel's latest CPUs with Nvidia's RTX GPUs. Choose an RTX 4070 or higher to benefit from the glass side and liquid cooling, which lifts it above rivals. **From £1,349 from dell.co.uk**

REVIEW **Issue 349, p54**

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from hp.com

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

REVIEW **Issue 335, p46**

Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money. **From £599 from dell.co.uk**

REVIEW **Issue 350, p47**

Apple iMac 24in (M3)

The iconic design remains the same, but the plain M3 chip inside the revamped iMac 24in is a revelation compared to the previous M1 version. The downside is that the base configuration includes a stingy 8GB of memory and a 256GB SSD. **From £1,399 from apple.com/uk**

REVIEW **Issue 352, p52**

CREATIVE WORKSTATIONS

Scan 3XS GWP TR Ada

Record breaker for £14,167 exc VAT

from scan.co.uk

A 64-core Ryzen Threadripper 7980X blows everything that went before out of the water with multithreaded tasks, while Nvidia's RTX 6000 Ada graphics dominates for viewport acceleration and GPU rendering. Even storage throughput is unparalleled. With a striking chassis and brilliant build quality, you'll want for nothing.

REVIEW **Issue 353, p52**

Armari Magnetar MC16R7

A strikingly fast workstation for the money, with Armari's customised liquid cooling extracting the most from an AMD Ryzen 9 7950X. With 64GB of DDR5 RAM and AMD's Radeon Pro W7800 in support, this is a fantastic value machine. **£3,758 exc VAT from armari.com**

REVIEW **Issue 348, p84**

PCSpecialist Onyx Pro

Even in a creative workstation, it makes a lot of sense to include Nvidia's consumer graphics due to its core-per-buck. Here, an Nvidia RTX 4090 partners with a Core i9-13900K and an incredible 192GB of RAM to tremendous effect. **£3,750 exc VAT from pcspecialist.co.uk/reviews**

REVIEW **Issue 348, p86**

TABLETS

Apple iPad Air (M2)

M2 power from £599

from apple.com/uk

We love the new iPad Pro, but for most people the M2 iPad Air is not only far better value but also all the tablet they'll need. It supports the Magic Keyboard and Pencil Pro, plus it's now available in both 11in and 13in sizes.
REVIEW **Issue 358, p50**

Apple iPad Pro (M4)

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from apple.com/uk**
REVIEW **Issue 358, p48**

OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.
£449 from oneplus.com
REVIEW **Issue 352, p86**

EVERYDAY PHONES

Motorola Moto G54 5G

Great looker for £180

from johnlewis.com

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.
REVIEW **Issue 355, p77**

Google Pixel 8a

We're fans of the Pixel 8 but you can save £200 and buy the 8a without missing out on any key features, including its advanced AI skills thanks to the same Tensor G3 chip inside. It's only when you zoom into snaps that you spot the camera quality difference.
128GB, £499 from store.google.com
REVIEW **Issue 358, p74**

Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too. **128GB, £364 from johnlewis.com**
REVIEW **Issue 358, p77**

PREMIUM PHONES

Samsung Galaxy S24 Ultra

AI cleverness from £1,249

from samsung.com/uk

The undeniably high price gets you a bunch of AI tools that will genuinely save you time (and money). While we miss the 10x optical zoom of the S23 Ultra, the 5x zoom camera and supporting cast capture brilliant images, while the S Pen is always on hand to scrawl notes and pictures.
REVIEW **Issue 354, p58**

Google Pixel 8

It's not a huge step up from the Pixel 7, but the added AI features are genuinely useful and it benefits from a handful of upgrades, too – including a 120Hz screen and the new Tensor G3 processor. If you don't mind the lack of optical zoom, it's a great buy for the price. **128GB, £699 from store.google.com**
REVIEW **Issue 351, p72**

Samsung Galaxy Z Flip5

While the Galaxy Z Fold5 has its undoubted attractions, the Flip5 pips it onto this A List slot thanks to it being £700 cheaper and through the usefulness of the expanded front display. It's also IP68 rated and packs a stellar chip, beating rival flip phones. **From £1,049 from samsung.com/uk**
REVIEW **Issue 349, p70**

EVERYDAY MONITORS

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429

from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (*see below*) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.
REVIEW **Issue 357, p88**

BenQ BL2790QT

A 27in, 1440p monitor that's packed with quality, from its brilliant OSD to several clever features designed to fight eye fatigue. Text and images look sharp and punchy, its USB-C docking capability is always welcome, and the speakers are surprisingly decent.
£270 from laptopsdirect.co.uk
REVIEW **Issue 357, p85**

Acer Verso B277 Ebmiprzxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub.
£149 from tinyurl.com/357acer277
REVIEW **Issue 357, p84**

PROFESSIONAL MONITORS

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206

exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.
REVIEW **Issue 357, p91**

Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too. **£2,149 exc VAT from wexphotovideo.com**
REVIEW **Issue 357, p90**

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts. **£333 exc VAT from scan.co.uk**
REVIEW **Issue 357, p86**

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from logitech.com

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.
REVIEW **Issue 356, p68**

Aukey PC-W3 1080p Webcam

If the thought of spending £219 on a webcam has you spluttering into your microphone then you should consider this far cheaper but high-quality alternative. Its colours are low-key in comparison to the best, but it still produces a sharp and detailed image. **£13 from ebay.co.uk**
REVIEW **Issue 321, p72**

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.
£329 from amazon.co.uk
REVIEW **Issue 352, p75**

HOME OFFICE PRINTERS

Epson EcoTank ET-2830

Ink tank all-in-one for £250

from epson.co.uk

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.
REVIEW **Issue 353, p85**

Canon Pixma TS8750

A fantastic choice for creative users that's equally at home printing photos as it is scanning artwork. Despite its high running costs, due to its reliance on cartridges, this is a superb all-in-one. **£159 from printerbase.co.uk**
REVIEW **Issue 353, p86**

HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.
£208 from printerland.com
REVIEW **Issue 353, p87**

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from canon.co.uk

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.
REVIEW **Issue 350, p58**

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from printerland.co.uk**
REVIEW **Issue 353, p84**

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from printerbase.co.uk**
REVIEW **Issue 341, p87**

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from amazon.co.uk

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.
REVIEW **Issue 341, p68**

Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.
£800 from netgear.com
REVIEW **Issue 353, p76**

Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support. **£125 from uk.store.asus.com**
REVIEW **Issue 350, p57**

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £600

from amazon.co.uk

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPWC8) should be enough for most premises.
REVIEW **Issue 349, p65**

Mercusys Halo H80X

A new subsidiary of TP-Link, Mercusys offers its parent brand's XE75 router some excellent value-for-money competition. Not as fast due to Wi-Fi 6 rather than Wi-Fi 6E, but it has all the bandwidth you need for everyday use and should deliver it stably throughout your house. There are plenty of features too. **2-pack, £161 from ebuyer.com**
REVIEW **Issue 341, p71**

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from amazon.co.uk**
REVIEW **Issue 350, p54**

BUSINESS WI-FI

NEW ENTRY

Zyxel WAX640S-6E

Wi-Fi 6E AP, £369 exc VAT

from broadbandbuyer.com

A nicely priced tri-band wireless access point ideally suited to businesses that want to provide the full range of wireless services. It's easy to deploy, wireless performance is good and Zyxel provides top-quality cloud management services.

REVIEW **Issue 353, p100**

Asus ExpertWiFi EBM68

Small businesses will find much to like with this simple-to-manage Wi-Fi 6 access point. AiMesh makes it incredibly easy to expand wireless coverage, performance is reasonable and it includes an impressive range of network security features. **2-pack, £540 exc VAT from amazon.co.uk**

REVIEW **Issue 353, p98**

Ruijie Reyee RG-RAP2260(E)

This competitively priced Wi-Fi 6 AP delivers business-class features and impressive performance, and the free Ruijie Cloud service offers a wide range of remote network management and monitoring tools. **£160 exc VAT from broadbandbuyer.com**

REVIEW **Issue 359, p103**

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.

REVIEW **Issue 346, p101**

Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs. This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps. **Diskless, £3,292 exc VAT from broadbandbuyer.com**

REVIEW **Issue 344, p96**

Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features. **5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com**

REVIEW **Issue 344, p98**

VIDEOCONFERENCING

Poly Studio X52 with TC10

Perfect middle man, £3,161 exc VAT

from meetingstore.co.uk

Ideal for businesses that want a professional videoconferencing solution for medium-sized meeting rooms. Video quality is excellent, speaker tracking fast, and the big choice of built-in VC apps makes it incredibly versatile.

REVIEW **Issue 353, p102**

Owl Labs Owl Bar

As a standalone videoconferencing room solution the Owl Bar has plenty to offer, with good video quality and super-smooth speaker tracking. It really comes into its own when paired with an Owl 3, though, as this unleashes a completely new dimension to your meetings. **£1,999 exc VAT from owllabs.co.uk**

REVIEW **Issue 352, p99**

Jabra PanaCast 50

This sleek cylinder delivers great video and audio quality, fast speaker tracking and a wealth of advanced features. Jabra's Xpress web portal offers smart remote management services, and the super-wide view helps make the PanaCast 50 ideal for all-inclusive meetings. **£867 exc VAT from uk.insight.com**

REVIEW **Issue 354, p100**

SCANNERS

Xerox N60w Pro Scanner

Speed demon, £766 exc VAT

from tradescanners.com

The N60w Pro offers tremendous value and versatility. It delivered up to 67ppm in our tests with great output quality, offers a plethora of connection options and makes walk-up scanning a breeze.

REVIEW **Issue 358, p101**

Brother ADS-4500W

Ideal for small businesses, the ADS-4500W offers a fine set of walk-up scan features and its output quality is beyond reproach, while Brother's Print&Scan app delivers great scan workflow management options. **£295 exc VAT from printerbase.co.uk**

REVIEW **Issue 358, p98**

Epson WorkForce ES-C320W

A space-saving wireless desktop scanner, the Epson WorkForce ES-C320W delivers nippy speeds – around 31ppm in our tests – and is backed with software that offers plenty of scan management features. **£180 exc VAT from printerland.co.uk**

REVIEW **Issue 358, p100**

SERVERS

Dell EMC PowerEdge T350

Xeon E-2300 power, from £1,399 exc VAT

from dell.co.uk

Perfect for SMBs and branch offices looking for an affordable and powerful single-socket tower server. Along with support for Xeon E-2300 CPUs and lots of memory, it has a high storage capacity, plenty of expansion space and is sturdily built.

REVIEW **Issue 335, p98**

Dell EMC PowerEdge R250

With prices starting at around £850 exc VAT for a Pentium Gold CPU, and the option of Xeon E-2300 series chips from £1,461 exc VAT, this is a slim, rack-mounted alternative to the more high-powered T350 that's ideal for SMBs. **From £845 exc VAT from dell.co.uk**

REVIEW **Issue 332, p98**

Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here. **£983 exc VAT from broadberry.co.uk**

REVIEW **Issue 318, p96**

SECURITY SOFTWARE

Avast Ultimate
Buy from retail and this is a bargain, with a solid VPN, anti-tracking software and handy detection fees on top of excellent protection. **10 devices, 2yrs, £30 from store.pcpro.co.uk**
REVIEW **Issue 355, p84**

G Data Total Protection
G Data provides straightforward, effective and inexpensive protection against malware and other threats to your system, making it a favourite despite its quirks. **5 devices, $82 from gdatasoftware.co.uk**
REVIEW **Issue 355, p87**

Avast One Essential
Avast One Essential has the same malware-detection engine as our top choice, but for free. It even includes 5GB of VPN services per month and a few system optimisation tools. **Free from avast.com**
REVIEW **Issue 355, p89**

VPNs

NordVPN
NordVPN won our VPN Labs for the second time running thanks to its consistent, fast speeds, great security features and excellent support for video streaming. **£80 for two years from nordvpn.com**
REVIEW **Issue 349, p86**

ProtonVPN
The best free VPN service available, with quick speeds and unlimited bandwidth. The paid-for service isn't cheap, but offers a bunch of useful extra features that might just tempt you into coughing up. **Free from protonvpn.com**
REVIEW **Issue 349, p88**

Surfshark
The fastest VPN we've tested, and it's generally a good performer in our region-shifted streaming tests, too. Cancellation is trickier than it should be, but it's a great-value choice for heavy VPN users. **£56 for two years from surfshark.com**
REVIEW **Issue 349, p89**

PASSWORD MANAGERS

NordPass
This hassle-free option is a great choice for both personal and business use, with a competitive price matched with all the features most people need. **£1.89 per month from nordpass.com**
REVIEW **Issue 350, p70**

Bitwarden
Free for individual use and open source, the only important thing Bitwarden lacks is phone support: it works with virtually every device and browser, and the paid option is well worth £10 per year. **Free from bitwarden.com**
REVIEW **Issue 350, p71**

Keeper
A great choice for businesses thanks to its focus on security and a zero-knowledge policy, and if you need more options then Keeper has them. **Business edition, from £2 per user per month from keepersecurity.com**
REVIEW **Issue 350, p72**

ENDPOINT PROTECTION

Sophos Intercept X Advanced
Delivers a huge range of endpoint protection measures for the price. It's simple to deploy, device and user policies add flexibility, and seamless integration with the Sophos Central cloud portal makes management simple. **500-999 users, 1 year, £36.50 each exc VAT from enterpriseav.co.uk**
REVIEW **Issue 351, p98**

WithSecure Elements EPP and EDR
High levels of automation make WithSecure a great choice for SMBs that want endpoint protection on a plate. It's easily managed from the cloud, too. **100-499 devices, £37 each per year exc VAT from withsecure.com**
REVIEW **Issue 351, p99**

CLOUD BACKUP

NEW ENTRY

IDrive Business
A top cloud backup choice for SMBs that want to protect on-premises systems and remote workers. Platform and business app support is outstanding, it's easy to use and the simple capacity-based subscriptions are incredibly good value. **5TB, £838 exc VAT per year from idrive.com**
REVIEW **Issue 359, p101**

NEW ENTRY

Acronis Cyber Protect 16 Advanced
Flexible subscriptions keep costs under control, the EDR service stays one step ahead of cybercriminals and it's easy to manage, too. **From £95 exc VAT per year from acronis.com**
REVIEW **Issue 359, p98**

VOIP SERVICES

3CX Phone System V20
Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**
REVIEW **Issue 357, p98**

TelephoneSystems.Cloud
A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a competitive price. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW **Issue 357, p100**

NETWORK MONITORING

Progress WhatsUp Gold 2023.1
Simple to deploy and offers an impressive range of network-monitoring tools. The choice of licensing plans makes it an affordable option for SMBs, and support teams will love its smart dashboard and NOC views. **Enterprise, 50 devices, £1,192 exc VAT per year from whatsupgold.com**
REVIEW **Issue 354, p99**

Paessler PRTG Network Monitor 23.4
A highly versatile network-monitoring package that delivers a wealth of information, and its all-inclusive price makes it a great choice for SMBs. **1,000 sensors, 1yr maintenance, €2,649 exc VAT from paessler.com**
REVIEW **Issue 354, p98**

REMOTE SUPPORT

IDrive RemotePC Team
IDrive's RemotePC Team will appeal to SMBs that want affordable cloud-hosted remote support for their offices and home workers. It's exceedingly simple to deploy, easy to manage and delivers tough access security measures. **First year, 50 computers, £172 exc VAT from remotepc.com**
REVIEW **Issue 349, p98**

NetSupport Manager 14
Delivers a wealth of support tools, including secure access to home workers, and licensing plans are good value. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW **Issue 349, p100**

UTM APPLIANCES

WatchGuard Firebox T45-CW
Businesses that hate internet downtime will love WatchGuard's Firebox T45-CW. It provides a wealth of top-class security services, can be easily cloud managed and delivers seamless 5G WAN failover. **Appliance with 3yr TSS, £4,015 exc VAT from broadbandbuyer.com**
REVIEW **Issue 354, p103**

Zyxel ZyWALL ATP500
This desktop appliance gives sophisticated protection against zero-day threats, is easily managed and very good value. **Appliance with 1yr Gold Security licence, £1,191 exc VAT from broadbandbuyer.com**
REVIEW **Issue 348, p99**

Eroding privacy is no longer bad Phorm

The shifting baseline of personal privacy makes yesteryear's scandals look tame

You can buy Barry Collins' personal details on a dark web near you. Email barry@mediabc.co.uk for a quote. @bazzacollins

I received an email the other day from **HaveIBeenPwned.com**, a site that informs you when your email address has been identified in a data breach. Apparently, I was one of the 361,468,099 pwned in a recent attack on Telegram. This was a breach involving more people than the entire population of the USA, and it barely provoked a tut from me. Just as being one of the 15 million victims of the recent Trello breach or one of the 70 million affected by the Naz.API attack barely registered. Not least because I still don't even know what Naz.API is.

Massive data leaks have become so routine that they simply wash over me. I barely bother writing about them, because few people read the articles when I do. We're so inured to our data being splashed far and wide that we're past the point of caring.

Security experts Barath Raghavan and Bruce Schneier made a similar point about people's attitudes to privacy in a recent article for the IEEE. The article explained how a scientist, Daniel Pauly, realised ecologists were making a huge mistake measuring the fish population in our seas when trying to determine an acceptable catch size for fishing fleets. The ecologists were aware that fish populations were declining, but they didn't notice how significant the decline was, because each new generation of scientists was comparing contemporary fish levels to the previous generation's. Each generation's baseline was lower than that of the previous one.

Pauly labelled this "shifting baseline syndrome", and Raghavan and Schneier argued that internet surveillance has put privacy on a similar trajectory, where we accept each successive erosion of our privacy because it's only slightly worse than what went before. We're not too bothered when Microsoft announces that its Windows Recall AI will sit there screening every piece of information we enter into our PCs, because we've already grown used to Alexa listening to all our conversations or Gmail scanning our inbox. "You have no privacy anyway," as Sun's Scott McNealy famously said almost 30 years ago. "Get over it."

> "I'd have to live like a digital monk if I tried to boycott every company that failed to adequately protect my data"

I guess one of the reasons I'm over it is that there's little I can do about it. When I switch on my TV and I'm confronted by a pop-up menu, listing the hundreds of different ad-tracking networks that Samsung shares my viewing habits with, what can I do? Untick each network, one by one, to ensure they don't track me? (Yes, you really have to do this.) Send the TV back to Currys?

Likewise, I can't realistically dump every internet service the moment it suffers a data breach because, frankly, there wouldn't be many left to choose from. HaveIBeenPwned tells me my personal details have been spilled by Adobe, Dropbox and Twitter, among many others over the years. I'd have to live like a digital monk if I tried to boycott every company that failed to adequately protect my data.

Talk of shifting baseline syndrome prompted me to cast my mind back to some of the privacy furores of the past and wonder whether they would still be considered scandalous today. Anyone remember Phorm, the company that became notorious in the mid-noughties for striking deals with some of Britain's biggest broadband providers to monitor your internet traffic and display targeted ads? That created an enormous stink at the time, the bad publicity eventually forcing partners such as BT and Virgin Media to abandon ship and disassociate themselves from Phorm.

> "Massive data leaks have become so routine they wash over me. We're so inured to our data being splashed far and wide that we're past caring"

Would it cause such a media rumpus today? Or has the notion of targeted advertising based on our online behaviour now become so commonplace that it would barely register? I'm pretty sure it wouldn't make *News at Ten*, like Phorm did.

So, if there's not much we can do about the erosion of our privacy individually, or even collectively, what hope is there? Sorry to say it, but not a lot. Ideally we need a privacy watchdog to bare its teeth, but unless you're a local council leaving laptops in the back of taxis, the woefully under-resourced Information Commissioner's Office barely seems interested. The EU authorities are a little more privacy conscious, but big tech evidently regards fines as the cost of doing business rather than a disincentive to abuse people's privacy.

Only when people flock to more privacy-focused products such as the Vivaldi browser, Proton email or the DuckDuckGo search engine will the big tech companies really pay attention. But all of those have been available for a decade or more. The fact they're all niche players suggests increased privacy isn't a massive driving factor for most consumers.

Like climate change, the shifting baseline of privacy shows no sign of reversing. Much like our overheating planet, we'll probably do something about it only when it's far too late.

barry@mediabc.co.uk

AI wants our stuff. It can back right off

Meta wants to start mining public Instagram and Facebook posts. That's a bad sign for the health of AI

Nicole Kobie is *PC Pro*'s futures editor. Yes, she knows she should just delete her Facebook and Instagram accounts. And her Google one. And go live under a rock or something.
@njkobie

OpenAI unveiled GPT-4o in May with advanced voice systems that sound more natural. To many people, it sounded like actress Scarlett Johansson, in particular her portrayal of an AI in the film *Her*.

That feeling was encouraged by CEO Sam Altman tweeting the word "her" at the time of the launch. Then the actress revealed she was contacted by the company a year ago to voice the AI assistant, but declined. OpenAI says there was no intent for the "Sky" voice, as it's known, to sound like ScarJo, and posted a blog detailing its timeline of actor auditions to prove it. But the voice was removed, and so far a lawsuit appears to have been avoided.

So that's what happens when an AI company allegedly takes someone's personal stuff without permission and outputs something recognisable. Except most of us aren't Scarlett Johansson and lack her legal team.

OpenAI didn't need Johansson's voice for its product to work. If the company did try to mimic the voice in *Her*, it was merely a nod to a film that doesn't give a very positive portrayal of the impact of technologies such as AI.

> "Those developing huge AI models need data to build their systems, and they're clearly getting a bit desperate"

Those developing huge AI models need data to build their systems, and they're clearly getting a bit desperate in their hunt for the good stuff. Google has signed a deal with Reddit to trawl through user posts. One dataset, known as Books3, was reportedly used by Meta and perhaps other companies – but it was full of copyright-covered books, sparking a lawsuit. And now Meta wants to scrape Instagram and Facebook for text and images.

Thanks to our relatively stringent data laws, those in the UK and Europe were, at the time of writing, offered a way to opt out. (In Instagram, head to Settings | About | Privacy Policy; I received confirmation that my data would be left alone within minutes.)

Why opt out? My Instagram account is set to private, meaning my audience is family and friends. That's important to me because my posts are largely about my toddler. And if Meta uses my photos for training, it means some unknown person is going to be paid to sit and apply labels to my posts, including the one announcing my daughter's birth. I didn't sign up for this. I don't benefit from it. I realised after I had opted out that Meta's data grab only applies to *public* posts – so my posts were never in danger.

But have you been on public-facing Facebook or Instagram lately? No-one wants to replicate the garbage spewed out by bots and influencers. We're going to end up with incredibly powerful AI models that offer us nonsense recipes, foolish parenting advice and gossip about *Bridgerton*.

Indeed, Google found this out the hard way with its AI Overview feature, which uses its Gemini AI to write answers to searched-for questions. Unsurprisingly, there were some bonkers results – including one that told people to keep the cheese from sliding off pizza using glue. This weird answer came via a joke made on Reddit in 2013.

With these shenanigans in mind, here's how to fix the AI industry. First, regulators must step up their game and ban this silly behaviour; activists from digital rights group Noyb have already filed complaints, and well done to them. Johansson shouldn't have to lawyer up to protect her own voice acting; regulators should be investigating that incident on her behalf. I shouldn't have to fill out a form on Instagram to keep personal photos private; regulators should be proactively slapping down this behaviour, not waiting for complaints and taking years to act.

> "We're going to end up with incredibly powerful AI models that offer us nonsense recipes, foolish parenting advice and gossip about *Bridgerton*"

Second, if AI companies are going to persist with taking user-generated content, we need to start filling it with "eat glue" style jokes. AI can't tell if we're serious. Let's drown the internet with goofy in-jokes and other poison-pill nonsense so AI can't make use of our work. It's a variation on "garbage in, garbage out": silly jokes in, silly jokes out. Even if further destroying the quality of online content doesn't stop AI companies from hoovering up our posts, at least the garbled output will make for amusing reading.

Third, AI companies need to be less reliant on big hauls of data. If they need Instagram posts for training, it's one heck of a bad sign. Go back to the drawing board with these models and rework them to be more efficient and require less data, or better data.

Of course, gobbling up the entirety of the internet, be it pirated books or private posts, is probably a lot easier than re-engineering models. Just like it's easier to find an actress who sounds like Johansson than it is to convince her to sell her voice.

In this case, the easy road isn't the right one. But AI developers are still clearly heading down that path, so it's time for regulators and the rest of us to add a few hurdles, be it massive fines or jokes about eating glue.

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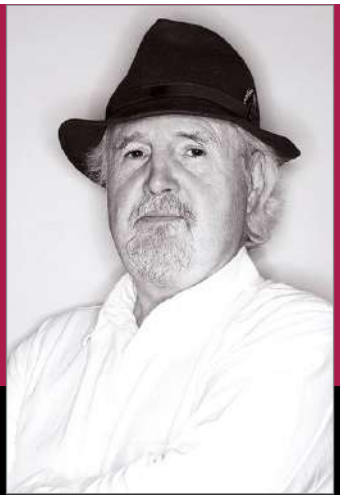
We're living in an AI world



Dick Pountain is editorial fellow of *PC Pro*. He thinks it will all end in tiers. Email dick@dickpountain.co.uk

Now that AI is everywhere, from the websites we visit to reviews of real-world places we eat, it's time to treat it as a utility

A few weeks ago I "attended" an interesting webinar organised by IT security firm Sophos, in which one of their researchers, Ben Gelman, demonstrated how someone with no knowledge of programming or web design can construct a convincing e-commerce site complete with product pictures, audio and video for around £4.23 in eight minutes. He did this live on screen using GPT4, Stable Diffusion and a couple of other free tools. Then he dropped the bombshell: by adding just a tiny bit of HTML, he created from this an agent-based framework capable of churning out hundreds or thousands of similar sites from simple text templates.

The web will soon be swamped by such sites, since it takes a lot longer than eight minutes to take one down. They may even disappear by themselves once a quota of suckers has been hooked. It's happening already; we've recently been "fleeced" by items of clothing and pottery that bear little resemblance to AI-augmented pictures on certain sites.

Last week we went to a restaurant we've enjoyed for years and suffered a revolting, shoddily prepared meal. We went to Tripadvisor and found hundreds of gushing five-star reviews, so on a hunch I filtered for one- and two-star reviews and found a few dozen accurate and mostly temperate complaints about drastic decline ("What have they done to...?"). Do all those five-stars mean most customers have no taste buds? Or were they paid for? Or are they AI-generated? The fact that I even ask that question speaks volumes: once it becomes known that you can use AI to prop up dodgy businesses, the technology has arrived in the mainstream.

On a different note, Apple just announced its deal with OpenAI to integrate ChatGPT into its operating system on all devices. Add similar projects from Meta and Google and it's clear it won't be long before "AI-query" becomes a commodity service on the same level as internet access and telecoms, with transactions in the billions. Ideally they'd all merge into a single "information utility", but that ideal is quite impossible to realise for several very serious reasons.

Reason one is intellectual property. All those streams of content are owned by different competing corporations, whose only rationale is profit rather than public education.

Reason two is that even were the AI vendors to get all the necessary permissions to use other people's content to train their GPT models, that content is going to become polluted at an exponentially increasing rate by the gibberings of billions of dodgy websites created by their own customers (or by Nicole's silly jokes; see previous page).

But reason three is the killer. We're all now aware of the colossal amounts of compute power needed to train and deploy GPT systems. Given present technology, it's quite impossible to train or fully query such a system on your local computer/phone/tablet (at the so-called "edge"), so these services will remain mostly cloud-based for the foreseeable future. Advances in analogue-based AI processors and similar technologies can reduce telecommunication bandwidth requirements to some extent by more"edge processing", but cloud AI servers will still consume as much of that old-fashioned utility – electricity – as a medium-sized African nation.

> "Once it becomes known that you can use AI to prop up dodgy businesses, the technology has arrived in the mainstream"

> "Cloud AI servers will still consume as much of that old-fashioned utility – electricity – as a medium-sized African nation"

This is all happening during a world-threatening climate crisis that most sane commentators agree requires us to find cleaner ways to generate electricity and equally importantly to use far less of it. AI companies are already starting to worry about where all that electricity is going to come from; the *Wall Street Journal* recently reported that OpenAI is in talks to buy "vast quantities" of energy from the startup nuclear fusion company Helion, in which CEO Sam Altman has invested $375m. Fusion power occupies an ontological niche rather like that of quantum computing, somewhere between hope and reality, real-soon-now-perhaps.

And then there's the question of how to pay for all this juice, which leads into the realm of blogger Cory Doctorow's concept of "enshittification". He summarises his caustic take on tech evolution thus:

"Here is how platforms die: First, they are good to their users; then they abuse their users to make things better for their business customers; finally, they abuse those business customers to claw back all the value for themselves. Then, they die."

You can read his argument on the "enshittification" of TikTok at **tinyurl.com/359tiktok**.

Corporations such as Apple and Amazon didn't spend the original AI research money and hence have to pay for it now, by buying the AI companies or by paying some kind of rent. The cost is so substantial they must get it back from their customers. The days of freebie services are numbered.

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Readers' comments

Your views and feedback from email and the web

Wishful thinking

I get a little puzzled at articles such as your Windows 12 wish list (*see issue 358, p26*). Some years ago, shortly after Windows 8 had been released and Windows 10 was already being mentioned, I asked the Microsoft representative at a security conference I attended how long it took to develop a version of Windows from inception to release, and at what point they realised they had a good version on their hands or a turkey.

BELOW Is there any point in publishing a Windows wishlist?

I seem to remember the response was that the gestation period was around eight years or so at the time, and that how the version was received by users depended on whether the marketing people or the developers had won the battle for looks, feel and features. Although it makes for interesting reading, and I suspect the development time is now much shorter, publishing a wish list for a version about to be released in three months' time does seem a little pointless! **Al Lawrence**

Editor-in-chief Tim Danton replies: In truth, and sadly, I don't think Microsoft comes to us for ideas, so this is more of a fantasy football list than us trying to enter the Premiership ourselves. But I also suspect the gestation period is now much shorter than it was, so who knows – perhaps we will see some of these features in Windows 12 when it's released.

Welcome to our AI overlords

So Darien Graham-Smith wants an "AI that watches what I'm doing on screen and pops up contextual tools to help" (see the Windows 12 feature mentioned above). Maybe it could be a cartoon paperclip… tap, tap… "I see you are writing a letter" tap, tap… (I quite liked Clippy, lots of folk didn't). Still, it will keep PC journalists in work, with articles such as "Get rid of Windows AI today" and " Stop Windows spying on you". Not to mention the evergreen "Is THIS the year of Linux on the desktop?"

That's if Windows AI hasn't already secretly replaced you all. I for one welcome our new AI overlords. **Robert Arrowsmith**

New NAS entry?

I read with interest the reviews of NAS drives (*see issue 358, p78*), but failed to spot my recent purchase of a LincStation N1. Perhaps it's just too new?

I bought it when my two-bay QNAP failed, which I bought a few years ago when my earlier two-bay Synology packed in as well. So far, over the couple of months I've had it, it's an amazing little bit of kit.

I use it as a backup for my Windows machines, a DNS server for ad and malware blocking using Pi-hole and the occasional play at a VM; the latest is a Win7 install to see if it worked. I've also tried the Technitium DNS server as an alternative to Pi-hole, and both work well using Docker images, just as in the QNAP.

However, IMHO, the user interface, as well as the updates,

Star letter

Cracking cryptic error codes

After reading "A question of support" from one of your readers (*see issue 358, p24*), I'd like your thoughts on the following issue. I'm the owner of an Epson XP-8600 printer, it works brilliantly, is compact, and does everything I need in a printer, except…

Recently it's being throwing up error code 302626 on the screen, stating that if the problem persists I should contact Epson support. So, after many fruitless searches on the internet, I finally threw in the towel and phoned Epson's support line. I tried three times, but the call queue was so long I gave up; on the fourth attempt, after a 30-minute wait, I eventually got through.

After trying to ascertain what the code meant, I was informed "we have so many codes, and we can't access them anyway, but we can book an engineer to visit you to fix the problem". So I was left none the wiser. I can't believe the engineer would perform this task for free, especially on a consumer product out of warranty and costing approximately £120 to replace with the newer XP-8700 model.

What is the point of a company making a product that tells you that you have an issue, but doesn't provide a sensible mechanism for finding out what it is? I can "fix" the problem by power cycling it, but it's occurring more frequently, and I'm not sure if it's serious or just annoying.

We're moving glacially towards a "Right to Repair" society, but surely part of that is being able to understand what issues you have, and in a transparent and easily accessible manner? **Peter Langan**

Editor-in-chief Tim Danton replies: Thanks for getting in touch, Peter, I definitely feel your pain on this one. I asked Epson for a comment and it replied: "Epson considers product longevity a critical part of its circular economy practices. We offer lifetime technical support to all our customers, and use refurbished products to replace faulty products, which in turn are refurbished for the same purpose."

Which is good to know, but doesn't actually help you with your error code, so I turned to our own contributing editor, Lee Grant: "I see you've spotted the flaw in the system. The code, which probably once meant something to someone, can only be properly decoded by the use of proprietary documentation or software, which are so secret that even the support team is not authorised to use them. You've not only highlighted why the right to repair is needed, but also how much companies such as Epson will need to adapt to make their devices more repairable. If it helps, 302626 is often caused by the Wi-Fi module, so if your 8600 is within USB cable range, disable the Wi-Fi (p62 of the manual) and see how you go."

This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a *PC Pro* Recommended award. Email letters@pcpro.co.uk

are far superior in the LincStation compared to QNAP and Synology because of the mature Unraid OS in use. This is for a six-drive licence that comes with the machine. I currently have two 4TB SATA SSDs in the two slots available with one as the parity disk, and plan to add NVMe versions into the four available slots at some point when finances allow.

I'm very impressed by the machine: slim, fast enough for my purposes, cool and quiet. Bizarrely, it has built-in wireless, but it only kicks in when you install a VM like Windows – curious or what? **Martin Rees**

Editor-in-chief Tim Danton replies: Thanks for emailing, Martin. I've earmarked the LincStation (or its successor) for inclusion in a future test!

Give us tips, please

You understandably praise the OnePlus Pad, and the OnePlus Stylo is a very good accessory to it. As well as drawing, it enables handwriting input to any app that uses the Gboard keyboard. I use it a lot – for writing this email, for example – but there's one drawback to which I would like to alert your readers. I recently dropped my Stylo and damaged the tip. A spare tip is supplied with the Stylo so I was able to change it, but I decided to get a few more to have on hand in case the same thing happened again. I was horrified to discover that OnePlus doesn't sell the tips separately. This means that if anything happens to the tip I'm currently using, my Stylo will be useless and my only option will be to purchase another at £99. This seems very bad of OnePlus; the tips can wear out and are clearly meant to be replaceable because a spare is included in the box, so why not make them available to buy separately? Perhaps you could speak to OnePlus about this; my inquiry was simply brushed off by OnePlus support, who said "spare tips are not listed on our website". **David Boettcher**

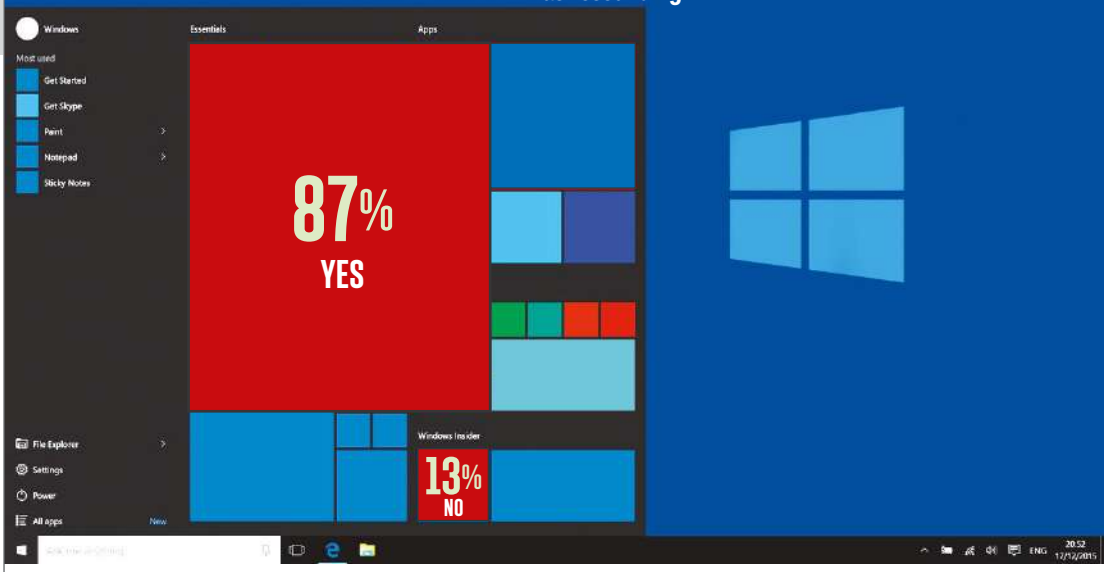
Editor-in-chief Tim Danton replies: Thanks, David. We will have a word, and hopefully this will change.

Corrections and amplifications

We spotted after this magazine's cover went to press that the price of the bonus software was incorrect. We stated £141 when it should be £116. Our apologies for any confusion or disappointment!

Readers' poll

We asked: do you, or anyone you support (friends, family, work), still run Windows 10? The answer was resounding.



It's perhaps unfair to call Windows 10 the cockroach of the operating system world, but it's certainly a tenacious little beast. Despite Microsoft's best attempts to lure people to Windows 11, Windows 10 continues to dominate in terms of the install base – as reflected by the 87% of our readers who still either run it for themselves or support it for friends, family or fellow workers.

"Yes yes yes," wrote Shoeshopboy on Discord, ticking off the friends, family and work in our question, "and now running a project to upgrade work devices to Windows 11 by end of year." Like many, he'll keep running home PCs that are otherwise healthy. Fellow Discorder metaphase said their parents are still using Windows 10 as "their PCs have CPUs that aren't automatically supported". And feel some sympathy for SouthendSites777's brother, who "has a £5K Dell that will not upgrade to 11".

Over on *PC Pro*'s Facebook page, Mike Webster explained that he decided to use the manual workarounds, saying he was able to "upgrade everything I have (and [I'll] take my chances with future lack of support)". Gary C Wood added that he'd done the same thing, but "can't see there will ever be a lack of support because it would be more effort for Microsoft to exclude us than to just let it run".

Similarly, over on X people mentioned that gaming rigs were stuck on Windows 10 due to motherboards lacking the TPM chip. We'll leave the last word to Lincolnshire Rebel. "I want an OS to do the basics well, and not force AI or ads on me. Windows 10 ticks that box!"

> "My computer runs Windows 10. As long as it works, don't bother to upgrade"
> **Yiu Yuen**

> "I constantly decline the W11 upgrade. W10 Pro is stable, the interface is good [and] everything I need runs correctly."
> **Jonathan Bowman**

> "Enrol on the Insider programme. The update then bypasses the restrictions."
> **Martin Buck**

> "My laptop wouldn't make the W11 upgrade so I moved to Linux. For my limited home use it's perfect."
> **Dale Williams**

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PHOTOSHOP AI SECRETS FOR PROs

Generative AI isn't a gimmick any more – it can be used for real-world professional workflows. **Barry Collins** explains how

If you toyed with generative AI a year or so ago, you could be forgiven for dismissing it as a gimmicky toy that would never seep into professional art workflows. You can't say that any more.

In the year or so since its beta release, Adobe's Firefly AI model has improved to the point where the company is now happy to embed AI tools in flagship products such as Photoshop and Lightroom. Adobe executives claim these AI tools are now used more often than the crop tool. They swear that's no exaggeration.

In this feature, I'm going to show how the Photoshop AI tools can be used for the types of jobs that professionals are asked to do every day: replacing backgrounds for product photography, adding "stock images" to websites, enhancing corporate headshots.

I'll reveal how to get the best from these tools, offer tips and techniques on how to get the best results, and point out where Adobe's AI engineers still have work to do. I'll also reveal how you can combine AI tools to get the best possible results, delivered at super-high resolutions that Adobe's own tools are currently unable to generate.

LEFT **Firefly delivered a great image of a coffee shop after a basic prompt**

GENERATING IMAGES FROM SCRATCH

Until recently, it wasn't possible to generate images from scratch from within Photoshop. There were workarounds to cheat it, but it wasn't officially supported. Now, if you start with a blank canvas, you have the option to generatively fill the space.

A little expectation setting first. The resolution of generated images is still limited to around 1,500 x 1,500 pixels. It can generate images in other aspect ratios, to be clear, but if you're hoping that you're going to use Firefly to generate something that you can use at poster scale, think again, unless you've got a decent upscaling tool such as Topaz Gigapixel AI. Adobe says improving the resolution of images is high on its to-do list, but that of course comes at a compute cost.

As we'll see, results can be erratic. Images generated by Adobe Firefly have hugely improved in the year or so since it was released, but they can still be blighted with obvious glitches, deformed hands and other flaws. You may need to do some work on generated images to make them suitable for publication.

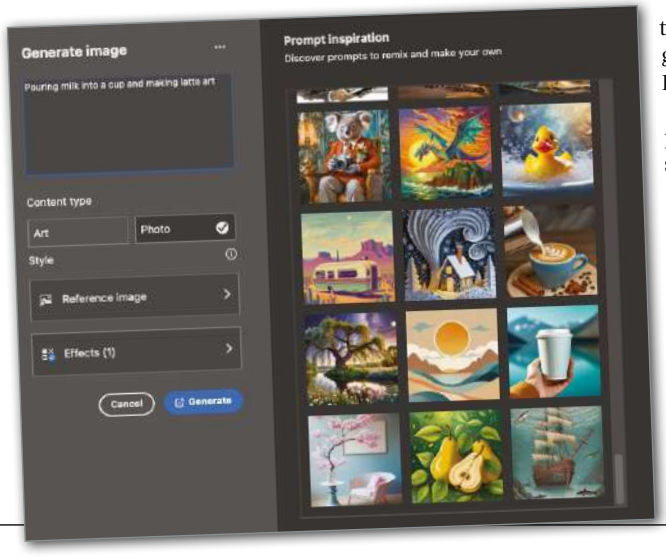
When you start with a blank canvas and select the option to generate an image, you're presented with a pop-up window that lets you do more than simply enter a text prompt. On the right-hand side you'll see a selection of "prompt inspiration" images that, when clicked on, autofill the text prompt box with the text that created that image. It's unlikely you're going to want an image of, say, "a retro man in a spacesuit on the moon, in magenta and green duotone", but if you like the styling of the image, you could keep the second half of that prompt and change the subject in the first.

Other options include telling the AI whether you want the image to look like a photo or a piece of art, and there's a wide range of preset effects you can choose from – effects such as "psychedelic" or "charcoal", of the kind you'll find in the filters gallery that has been in Photoshop for donkey's years.

There's also the option to provide a reference image, showing the AI the visual style that you'd like to copy. We'll come to using reference images later.

So, let's start generating the type of images you might use for professional purposes. Let's say you're building a website for an upmarket café and you want an inviting artisan coffee image to lure customers in. In the prompt inspiration panel, there's already an image like this, and

BELOW **The prompt inspiration panel can give you ideas**



when you click on it the prompt box is filled with "pouring milk into a cup and making latte art".

However, you can add detail to tailor the image to your specific needs; you don't just have to take the suggested prompt. So, I added "British coffee shop, sunlight through the windows" to the end of the prompt text. Assuming you've already created a canvas with the required image dimensions, you can hit Generate and Firefly will deliver three options. You can click Generate again if none of them hits the mark.

At the first attempt, however, Firefly delivers a great image. Notice details such as the reflection of the server's hand in the metal jug and the reflection of the wood grain in the coffee cup. It's not perfect – you can see the reflected grain on the cup doesn't precisely match the grain of the bench – but it's not something 99.9% of people would notice when casually browsing a website, and it can be easily tidied up.

Firefly had greater difficulty with a second image I asked for. "A young woman, aged around 30, sitting on a sofa. She's smiling, as if reading a message from a friend. She's sitting on a modern green sofa. She's wearing a white shirt with blue jeans." I also selected a bokeh effect from the list of presets.

THE AI FOLLOWED OUR STYLING INSTRUCTIONS TO THE LETTER, WITH THE SOFA, THE CLOTHES AND THE AGE OF THE WOMAN PRETTY MUCH BANG ON

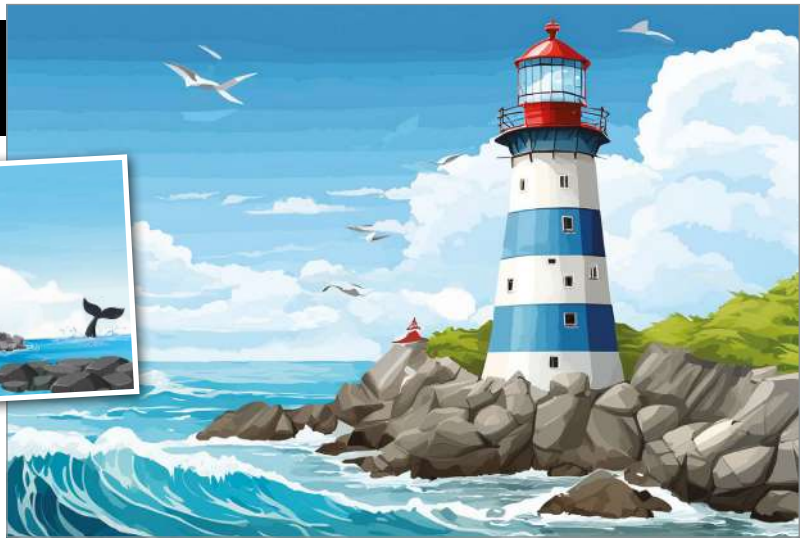
By the way, the above prompt is a good example of how to get accurate results from generative AI art services: don't leave important things to chance. If an art director was setting up a photo shoot of the scene, you can bet your life they'd be picking the look of the model, what they're wearing, the look of the room. If you want AI to deliver reliable results you need to think like an art director.

As you can see on the right, the AI followed our styling instructions to the letter, with the sofa, the clothes and the age of the woman pretty much bang on. But if you look closely, there are glitches with the hands in all of them, in particular in the worst example shown at the bottom, where the fingers are awkwardly interlocked and the hands look too big. The right knee of the blonde woman also has an odd bulge, and her watch is floating slightly off the strap.

Still, with a little Photoshop work you could easily make the first couple of images usable, especially if they're only used at a limited size on a website or a magazine page.

RIGHT It's vital to be specific in your prompt about what exactly you want

REFERENCE IMAGES



ABOVE/RIGHT We changed details in the reference image above to create our own image (right)

Another new feature added to Photoshop in the latest update is the option to provide reference images. So instead of struggling to find the right words to describe the style of image you're looking for, you can upload a photograph that embodies the style you're hoping to create.

Don't get the wrong impression of this feature: it's not designed to create an AI photocopy of the image you provide, it's intended to provide inspiration, to retain characteristics.

You can provide reference images whether you're generating images from scratch or only want to generate part of an image. Here (*see right*), for example, we've downloaded a royalty-free vector-art style image from Vecteezy and used that as a reference image. But we've also added extra detail to the prompt, asking for a blue and white lighthouse instead of the traditional red and white that's in the reference image.

The generated image is similar in style to the reference image and the AI has obeyed our direction on the colour of the generated lighthouse. Again, there are flaws in the generated image. There's an indistinct red object in the background, the rails at the top of the lighthouse are a little distorted, and there are probably too many windows in the lighthouse itself, but all of these would be reasonably easy to correct by anyone halfway competent with Photoshop.

Remember, you don't only have the ability to remove objects from generated images, but add to them, too. I drew a small selection box on the horizon line and asked the AI to draw a red yacht. Note that it does its best to maintain the styling of the original image; it doesn't just plonk a photo-realistic yacht on to the page.

As stated earlier, reference images can be used to change parts of an image too. Below, for example, is a byline portrait of a handsome young journalist whose identity has been withheld for reasons for privacy. He's wearing a casual checked shirt, but what if we're billing him as a speaker at our business conference and want him wearing something smarter?

To make this happen, you make a selection of the object you want to replace (in this case, the shirt), click the generative fill box that pops up when you make a selection, and then select the reference image icon next to the text-prompt entry box. I tried a variety of outfits, some more successfully applied than others, before settling on this smart blue suit jacket. I gave the AI no other instructions; I simply provided the reference image.

As you can see, it replaced the casual shirt with a similar coloured, modern-looking suit, and put a matching shirt underneath the suit, even though there wasn't one in the reference image. There are, again, imperfections: the left arm/shoulder has a rough texture, the shirt buttons are a little ornate and the bottom button is oddly positioned. But it only took me a few minutes with other Photoshop tools (namely the clone brush and the context-aware move tool) to tidy the image, as shown. I even selected the fancy buttons and replaced them with less conspicuous AI-generated alternatives.

BELOW Smarten up! Simply select the object you want to replace and click the reference image icon

REMOVE PEOPLE

People can be decidedly awkward, wandering into your photos when you'd really rather they b****d off. In some circumstances, people are simply unavoidable, such as popular tourist locations, and unless you fancy spending the next ten years in HMP Wandsworth for calling in a fake bomb hoax there's no easy way to get rid of them. That's about to change.**

Although not in the current beta, Adobe has demonstrated a Photoshop feature that allows you to select all the people in an image from a drop-down menu, in the same way you can select a subject. You can them perform a generative remove, where Photoshop vanishes the people and fills in the gaps.

To be clear, Photoshop has offered this "context-aware fill" facility for many years to remove objects, but until now you've had to select each person individually and brush them out. This facility selects every person in an image automatically. In the example I was shown, dozens of people littering the Colosseum and the steps to the British Museum were zonked in two clicks.

To be doubly clear, I've mocked up the image used here – it didn't use the new Photoshop feature.

LEFT Get shot of unwelcome bodies in your shots

REMOVE AND REPLACE THE BACKGROUND

The option to remove backgrounds and replace them with something AI generated could be a brilliant timesaver for those who deal with product photography.

We've used a couple of examples here: a perfume bottom that was AI generated in the first place (let's call it *Eau de Pro*) and an actual product shot of some high-heeled shoes.

As soon as you open the photos in Photoshop, the option to remove the background should appear in the floating context menu. This background removal tool has improved enormously in recent versions, and even with the dark shadows underneath the glass bottle, the tool accurately cut out the perfume bottle.

With the background removed, the context menu now switches to "generate background", and you can enter a text prompt with your desired backdrop. Alternatively, if you've seen a backdrop you like in another photo, you can upload a reference image for your background.

This feature is ideal for creating product images for different campaigns. With the perfume bottle, for example, I created backgrounds for a summery ad campaign with flowers in the background, one with the perfume bottle sat on a plinth, and another with a glittery effect that you might use in a Christmas brochure. Note how the pink of the bottle's glass is reflected in the glitter, making it look like actual product photography.




ABOVE Changing backgrounds for *Eau de Pro*

The shoes, meanwhile, have been given a crushed velvet background, a vinyl plastic look and a snowy backdrop for the Christmas party wear promotions. One of the great things about the generative images that Photoshop creates is that the backgrounds are added on a separate layer. That meant that when the "red vinyl" background I asked for on the shoes came out a funny grey colour, I could simply select the background layer and adjust the colours, rather than having to keep generating images (and burning through credits) until I got the desired colour.

There's a lot of trial and error in finding the right prompts for backgrounds, and I found Photoshop often responded better to themes (such as "Christmas party" or "summer fields") than specifying particular items or shapes.



BELOW Brought to heel: backgrounds are generated as a separate layer

THERE'S A LOT OF TRIAL AND ERROR IN FINDING THE RIGHT PROMPTS FOR BACKGROUNDS

LEFT The final AI-generated artwork

COMBINE GENERATIVE AI SERVICES

Photoshop's AI tools are rapidly improving, but they're by no means the best in the business for every task. When it comes to straight image generation, I'm yet to see a service that consistently outperforms Midjourney for the sheer quality and variety of images it can generate. And as mentioned earlier, the resolution of images generated by Firefly is limited, which means you may need to take advantage of dedicated upscaling tools if you want to use those images at any great size. So, there may be some jobs where it makes sense to combine generative AI tools, getting them each to work to their particular strengths.

Here, for example, I started by generating an image of a stormy sky in Midjourney. I'll admit this wasn't a finely crafted prompt. I was playing around, seeing how the AI would react to more abstract prompts, so the words that created this starter image were merely "storms may come". I used the Midjourney tool that allows you to extend an image to make a more panoramic landscape.

Next, I imported the image into Photoshop. I noticed the horizon was a little wonky, so I corrected that with the straightening tool. Then I decided to use Photoshop's generative AI to insert a father and daughter into the image. Midjourney does allow you to change parts of an image, but Photoshop's tools offer a much greater degree of control.

I drew a small selection box in the grassy areas on the left, where I wanted the people to stand, and in the generative AI context box that appeared I typed: "A father and daughter staring at the horizon, backs to camera, wearing winter clothes." I chose the best of the three generated images. Note the way the Photoshop AI acknowledges the light source is coming from the right of the photo and adds highlights to the right of the people's hats and clothes, making it look more authentic.

So far, so good, but even Midjourney's upscaled images only hit a size of 2,888 x 1,444 in this instance, which means you can't really print the artwork at even A4 size, nor use it as a wallpaper on a high-def screen, without it getting blurry. So, I opened the image into Topaz Gigapixel 7, the best AI upscaler I've come across.

This has dedicated modes for generative AI art and it automatically detected it as such. I doubled the resolution of the image, and as you can see from the screenshot, it uses AI to effectively add detail back into the image. You obviously have to take care if you're using such software on real photos, as it can invent facial features, for example. But on AI-generated content, it's extremely effective at upscaling artwork that can be printed up to A3 size or beyond.

And so, by using a combination of three different AI tools, you end up with a piece of artwork that you could print and hang on a wall.

RIGHT The original image at the top was created in Midjourney

RIGHT The man and the girl were added to the image in Photoshop

BELOW Finally, the image was upscaled in Topaz Gigapixel 7

LIGHTROOM'S AI TRICKS

Adobe Lightroom is the app many photographers will use to manage their photos and make routine edits, and that too has been given the AI treatment in the most recent version.

There are two main AI features in Lightroom (both the Classic and regular versions, as well as the mobile and tablet apps): Lens Blur and Generative Remove.

LEFT Lightroom successfully removed a person from this image

LENS BLUR

Lens Blur allows you to adjust the aperture you used to take the photo after the event, artificially adding blur where none exists in the original image. It can work convincingly, but only if you apply this new feature via the correct method.

There are two ways to add lens blur. Adobe has added an "Adaptive: Blur Background" section to its growing list of default presets, where with a single click you can apply subtle or strong background blurring, or choose from various blur patterns such as circle, geometric or bubble, which are only really apparent when you have catch lights in the background.

This preset didn't deliver great results in my tests, especially when the strong filter was applied. It made the blur look obviously artificial, like a bad smartphone filter, and you could see obvious signs of software manipulation, such as smoothing of a person's outline in the background.

The effect was much more convincing when applied using the new Lens Blur panel in the right-hand menu of Lightroom Classic. Here you're given much greater control over how and where the blur is applied. You still get to choose the strength and shape of the blur, but now you can also change the focus range, using sliders to define what should be in focus and what should be blurred. If you tick the Visualise Depth box, your photo is swathed in a coloured overlay, with in-focus items shown in light colours, and background items darker. This really helps fine-tune the focus range (which is also coloured to match), making it much easier to apply a convincing degree of background blur.

If the AI fails to get the depth mapping correct, keeping a background item in sharp focus, you can use the Brush Refinement tools in the Lens Blur panel to manually blur them. Don't be fooled by the "Focus" brush, however. Although it can apply sharpening to an item in your photo, it can't magically restore detail to an item that's heavily blurred in the original image.

ABOVE The AI struggled to remove the dog in the background of the image on the right

GENERATIVE REMOVE

Generative Remove is arguably long overdue in Lightroom. Although Lightroom has had a healing brush that could remove unwanted objects for years, this was only useful for small blemishes such as dust spots or freckles. The new tool finally lets you remove larger objects without having to edit in Photoshop.

I tested the tool on a series of photos I took at a recent marathon, and it worked well – with the odd exception. The key thing is to make sure you're in the right mode; when you open the Remove panel in Lightroom Classic it defaults to the healing brush rather than Generative Remove. Look for the eraser icon rather than the sticking plaster, then make sure the Generative AI box is ticked. To remove an item, you simply brush over them.

It worked fine in the majority of my tests, whether it was removing a small object or something much larger. I was able to remove a person that was standing almost the full height of the image in one shot (shown with the white outline above), and what was particularly impressive was how Lightroom adjusted the blur in the generated background, so that the grass in the in-focus foreground remained sharp, while the rest was gradually blurred into the distance.

Lightroom did really struggle with removing a dog in the background of one my photos, however. I think it was fooled by a railing running behind the dog, prompting the AI to hallucinate weird objects to put in place of the dog. I tried several times with the same image, but every AI-generated variation added a random object to the photo.

ABOVE The original photo (left), and after blurring the background (right)

SMART CITIES

THE LONG HISTORY OF THEIR FUTURE

Nicole Kobie traces the roots of smart cities back to Victorian London, before taking us on a journey to the concept's present and future

It's Victorian London, and cholera is creeping through the streets of Soho. Famously, Dr John Snow deduced that the disease wasn't spread via bad smells in the air as believed but through water – in particular, a single water pump.

He figured that out with data and a map. The good doctor simply plotted the deaths of infected people within the district and had the good sense to notice that they lived near the same water pump on Broad Street. As the story goes, he ended the outbreak by removing the pump's handle. And so data analytics within cities was born.

A few years later, in 1868, the world's first traffic light was installed, at Bridge Street near Parliament Square in London. This was before cars, but a thousand pedestrians were being killed each year on the city's roads thanks to carriages. The signal wasn't smart: the six-metre-high light was manually operated, with gas-powered lights. And the traffic light lasted less than a year, taken out by a sub-pavement gas pipe explosion.

Despite such explosive origins, the idea eventually spread around the world. Automated traffic lights were introduced in California in 1920, with signals that used timers. By 1928, the use of automated signals let New York slash its traffic police from 6,000 officers to 500. But it also meant pedestrians and drivers had to obey the directions of machines rather than humans to smooth urban life.

Automation required road data and traffic technology to be combined, which allowed the development of so-called "green waves": holding all the signals going in one direction for a set of cars so they could just roll on through without stopping. This staggered system doubled commuting speeds along Sixteenth Street in Washington, DC, in 1926.

As cars took up more of city roads, authorities knew they needed to do more to address traffic. The first computerised road traffic control system arrived in Toronto in 1963, set up by Josef Kates' consultancy KCS and its Traffic Research division, run by Leonardo Casciato. "Toronto has a traffic cop with arms seven miles long and getting longer," explained one report from the local *Star-Phoenix*. "It's a computer that already controls more than 500 traffic lights in an 80-square-mile area."

Wires connected to sensors were buried in the road ahead of intersections, tracking the speed and direction of each car that passed using electrical induction, and sending that data to the central computer for processing to decide how long to keep the light green. The $4 million system handled 1.25 million daily trips, with the city aiming to speed up rush-hour traffic by 15 to 20%, according to local media reports. It worked even better than that: trials showed a 38% boost in speeds in downtown Toronto.

It didn't take long before city authorities decided they could manage much more than traffic jams with computers

It didn't take long before city authorities decided they could manage much more than traffic jams with computers. They started to look at cities as flows of information and people as problems to be solved with models and algorithms. Data was knowledge, computing was science, and whatever the models spat out must then be correct.

Good data, bad data

In 1969, Jay Forrester's Urban Dynamics laid out a scientific way of looking at cities as systems based on industrial dynamics, which considers the feedback loops and interactions in a network to understand how to make it work better. It sounds clever, but there was a clear fault in his models, and it was likely that he treated all cities the same when they are very much different places. If you wanted to solve unemployment, for instance, his models didn't suggest training or government support, but clearing out slums in place of more expensive housing – in other words, notes one researcher, gentrification. Trying to

Order Nicole's complete book

This article is an edited excerpt from the Smart Cities chapter in Nicole Kobie's new book, published by Bloomsbury, *The Long History of the Future: Why Tomorrow's Tech Still Isn't Here*. The hardcover edition costs £18.99 and the Kindle version is £13.29.

TOP The first traffic light was installed in London in 1868

ABOVE Automated traffic lights were commonplace by the 1930s

systemise, automate and analyse cities based on data is a flawed way of thinking: there's plenty about a city that can't be collected in the numerical format necessary for a computer to analyse. And not everything can be automated – we've had traffic lights directing cars for more than a century, but lollipop ladies still help children cross safely outside schools. Analysing how a city works and what solutions it needs also can't be done from one angle. This is why we have elected mayors and councils full of people; deciding what to prioritise is deeply political.

LA gave such data gathering a go in the 1960s, noted academic and urban planner Mark Vallianatos in an article for Gizmodo (**tinyurl.com/359giz**), as part of a wider plan to build an Urban Information System to address everything from poverty to land use. In 1967, the city officially formed its Community Analysis Bureau (CAB), aiming to give decision-makers insights to help prioritise LA's needs.

The city was broken up into 727 census tracts (neighbourhoods or districts) with clusters based on 66 pieces of data to describe them, including ethnicity, crime rate, income and housing. For example, "post-war suburbs" was a cluster that applied across 76 census tracts; they're largely middle class, middle-aged and white, with income and education levels just above average; they tend to own cars and not take public transport. Another cluster is "singles": younger (average age 33) people living in higher-density apartments, with a high level of education and an even higher level of employment – it's your *Sex and the City* crew. And then there's "high income" – mostly white, with large homes, and incomes three times as high as any other cluster. But there were surprises: this cluster, which was found in Encino and Brentwood, also had the highest concentration of unrelated individuals in poverty, double the city average. The report pins this on low-salaried "live-in servants" or a statistical error.

Suburbanites, single professionals, rich people: those are all fairly obvious. Other clusters included "the Chinese", which unsurprisingly included Chinatown; the "Once Elegant", a mix of elderly people and younger Hispanic families; and "Blacks of Moderate Income", which is 75% populated by black people, has a high rate of female workers, and low crime. "This is the first time this technique has ever been used to describe a city," wrote Robert Joyce, the CAB director, in its first report.

Data sources informing those clusters were varied. The team digitised Census Bureau data, but also used aerial photos to assess the physical environment of a district, with staff scoring it based on characteristics such as litter, vegetation and whether homes had "convenience structures" such as patios and swimming pools, noted Vallianatos. The scores were checked by driving through a neighbourhood to look for signs of neglect – a problematic way to collect data that introduces bias. Graffiti and untrimmed lawns are signs of neglect in some neighbourhoods, and evidence of hipster artists and no-mow-May in others.

The goal of all this was to figure out which neighbourhoods needed help, and what sort of help. Vallianatos noted that the bureau didn't actually need all 66 data points that were used to define the clusters. Just three acted as effective red flags: age of housing, average birth weight of babies and sixth- grade reading scores. But here's where it all so often falls down: now it was up to politicians to take action. Handily, one thing that data analytics is good at is winning grants – how do

you say no to scientific evidence, after all? Hyper-local grants were doled out to improve streets and parks, expand social services and so on. In the end, the CAB became a way to get grants, rather than a way to inform decision-making. As computers became common, the CAB was eventually folded into wider planning divisions, shedding the original motivation to add to the "quality of life; for each and every citizen of Los Angeles".

From data to smarts

As a formalised idea, the idea of tech and analytics to run cities came into its own because of Bill and Hillary Clinton. In 2005, the Clinton Foundation handed networking giant Cisco a challenge via its Clinton Global Initiative: figure out how to make cities sustainable.

That sparked the Connected Urban Development programme – you can see why the industry ended up being called "smart cities" in the long run as CUD is a terrible acronym – as well as a series of conferences. Amsterdam, San Francisco and Seoul were chosen for pilot programmes to develop technologies to slash carbon emissions, with the aim of creating techniques applicable in other cities. In Amsterdam, they invented co-working spaces centred on Cisco's TelePresence videoconferencing system, saving carbon emissions from commuting. In Seoul, Cisco built a web app for planning travel that showed carbon emissions for each route. For San Francisco, it built a digital map to track progress on carbon reduction goals, as well as setting up a Living Innovation Laboratory at the Hunters Point Shipyard residential redevelopment – though health concerns over the former nuclear test lab on the site proved it neither smart nor sustainable. That smart city lab doesn't appear to have been built.

Now it's no surprise that if you ask a networking company to fix cities, it's going to recommend solutions that involve a lot of networking equipment. Ask Cisco to fix cities, and it will suggest you install superfast broadband to access its videoconferencing system. After the five-year partnership with the Clinton Foundation ran its course, CUD was handed to the Climate Group, an environmental non-profit, and Cisco evolved the benevolent work into commercial products under the Smart and Connected Communities name, though it later also used the term "intelligent urbanisation".

At around the same time, the term "smart city" was popularised by IBM, which first started pitching the idea in 2009; before that, there was barely any mention of the phrase. That year, researchers Susanne Dirks and Mary Keeling discussed the necessity of smarter cities in a white paper for the IBM Institute for Business Value, saying "to seize opportunities and build sustainable prosperity, cities need to become 'smarter'".

Birth of smart cities

With that IBM paper, tech suppliers took the idea of governing by consultancy and absolutely ran flat out. To be fair to Dirks and Keeling, their argument is sound: technology can offer better operational controls at lower costs. And it was increasingly necessary: in 2008, for the first time, most of the world's people lived in cities rather than rural areas. That added stress to transport systems, hospitals, trade and utilities such as power and energy. According to Dirks and Keeling, that required cities to become "instrumented, interconnected and intelligent" – which simply means digitising, connecting it all up via the web and analysing everything – while recognising that cities were interrelated "systems of systems".

TOP IBM's smarter cities project in Rio was compared to "a Bond villain's lair"

ABOVE The Rio scheme was used to aid public transportation

The first major IBM "smarter cities" project was in Rio de Janeiro, beginning in 2010 as part of the preparations for Brazil holding the 2014 FIFA World Cup and the 2016 Olympic Games. The centrepiece of the project was the control room. According to the *New York Times*, it looked straight out of NASA, while the *Guardian* compared it to "a Bond villain's techno-lair". The operations centre had a massive wall four monitors high and 20 wide, showing weather predictions and mapping car accidents and power failures, as well as displaying video streams of stations and key intersections. Around 70 employees watched this dashboard from banks of desks with their own displays, all wearing white jumpsuits – allegedly to encourage solidarity rather than just because it looks cool.

Of course, watching a video feed of a busy station doesn't help you do much about the crowds, so IBM pulled together relevant data, and algorithms looked for patterns. Guru Banavar, IBM's CTO for the public sector at the time, told the *New York Times* it was "sense-making software". Rio needed that, mayor Eduardo Paes said, after a landslide and flood hit the city and he realised there was no way to see an overview of what was happening.

While it's neat to see where all your buses are and handy to manage emergency response in case of a disaster, a real-time dashboard only goes so far when it comes to addressing the daily problems facing most people. A study of the Rio smart city system by University of Zurich researcher Christopher Gaffney found it "mostly lacking" – in large part because the whizzy dashboard didn't

address "problems of radical inequality, or systemic poor governance, or compromised urban planning agendas – all of which continue to be the 'dumbest' elements of Rio de Janeiro". The system had limited coverage and functions, despite the big displays.

In addition, the analysis noted that the out-of-the-box software provided by IBM wasn't always suitable, and collaboration was difficult, meaning Rio city employees largely wrote their own software.

Much of the smart city dream is illustrated and epitomised by dashboards. They're modern and futuristic, offering a perfect backdrop for media interviews during disasters to show that everything is under control, as Rio's mayor liked to do. On the other hand, city staff only consider what is on the displays, what can be counted numerically and plugged into an algorithm, literally leaving more complex aspects of city life out of the room where decisions are made.

While Rio's room-sized dashboard beguiled at first, it soon became clear that even when such a setup technically works, it's often little more than just displays of charts and video feeds, rather than actual smart analytics of a city system. But they often don't work. Antoni Vives helped build Barcelona's smart city system and toured other cities to see their projects, visiting an unnamed South American city's situation room with the local mayor.

"It was obvious that it hadn't been used in months: dust on the tables, disconnected screens, ageing computers," Vives wrote in his memoir of the Barcelona project. "The danger of large companies on the hunt for an unsuspecting mayor is that they might fill the streets with sensors that don't do anything, and offices with screens that do even less."

ABOVE **Cisco's videoconferencing tech was well ahead of the curve**

Or they might build cities out of nothing that no-one wants to live in.

The Songdo New City

Along the edge of Incheon, South Korea, a new district on a 600-hectare island was being planned. Announced in 2004, Songdo New City was unveiled as a Korean rival to Shanghai, Hong Kong and Singapore, beginning with a conference centre. By the time of its projected completion, around 2012, the project's costs had risen to $35 billion, with canals mimicking those of Venice, a park modelled on Central Park in New York City, and an opera house that nods to the one in Sydney, Australia. It aimed to house 300,000 residents working in sectors such as IT and marketing across a business centre the size of downtown Boston.

A few years before IBM started using the "smart city" term, Korea had its own: "ubiquitous city", or U-city. And that idea would be applied to Songdo by John Kim, a former Yahoo designer who had been approached to build tech into the new city. Songdo would be a test bed for new tech but also show off what life could be like when everything is digitised or, as they called it, U-Life. That included smart rubbish bins that sucked garbage into tubes to be recycled, streetside computers for anyone to use, and smart homes with phone-controlled lights and heating, as well as intelligent road pricing (automated toll roads, basically), smart ads that changed to reflect who was looking at them, and automated parcel delivery.

In 2005, while buildings were still being planned in Songdo, Kim promised a world organised around a cutting-edge new technology: RFID cards. These would be used by residents not only to open their front doors but also to access transport such as buses or bike shares, pay parking machines or even just to see a film, Kim said at the time. "It will be anonymous, won't be linked to your identity, and if lost you can quickly cancel the card and reset your door lock," he told the *New York Times*.

Songdo also promised citizens would have the ability to make video calls, stream video content at any time and have access to their digital content anywhere in the city. Kim's description of Songdo is the life many of us lead now, we just didn't need to dredge the sea to build an island first. Sure, it's easy to laugh at this as simply what happened as mobile connections improved, but for context, at this point Netflix was still mailing DVDs rather than streaming movies on demand (that didn't start until 2007).

In 2005, the plan for Songdo was to build the technology infrastructure locally and look to overseas tech companies for support as partners. In 2011, Cisco signed on, beginning with an investment in a new joint venture called Songdo U-Life, including the use of Cisco networking to connect the island's buildings. The press release promised more than 10,000 Cisco TelePresence units for videoconferencing, so residents could access education and concierge services, as well as sensors embedded

BELOW **Songdo in South Korea was designed from the ground up as a smart city**

The term 'smart city' was popularised by IBM, which first started pitching the idea in 2009

in buildings to track energy use. This would allow residents to live a "technology-enabled lifestyle through digital infrastructure systems designed and built directly into the city's framework".

After 15 years of work, it was clear Songdo wasn't the draw that its creators had hoped, with only a quarter to a third of the expected 300,000 residents. A local blogger said, "future South Korean zombie movies could film here without having to worry about anyone getting in the way". Others say it depends on where in the city you go, finding outposts of liveliness among the otherwise quiet streets. The problem appears to be twofold. First, not enough companies rushed in to set up business, giving people little reason to live in an empty area that's more expensive than neighbouring ones. And second, streaming movies, video calls and smart homes are all now widely available – there's no need to move to a lonely "smart city" to access such luxuries.

This is the inherent problem with building a smart city: the "smarts" are often out of date before anyone moves in. The streetside computers, videoconferencing and RFID tags that sounded cutting-edge when Songdo was first planned are useless now that we have smartphones in our pockets.

Digs about zombies and out-of-date tech aside, it seems the mistake was building Songdo all at once, rather than letting it evolve organically, while locking in technology that quickly aged. If only there was another solution from another global megacorporation.

Along comes Google

Sidewalk Labs was quietly formed in 2015 to give Google co-founder Larry Page's "urban innovation" ideas – no one wants to call them "smart cities" any more – a place to live under the umbrella company, Alphabet. Core to his thinking was a desire to rebuild cities without having to deal with regulators and city authorities; Page even joked that building on the Moon would be easier than negotiating with municipal governments, according to Josh O'Kane's *Sideways*, a detailed look at the short-lived company's Canadian project.

ABOVE Utrecht in the Netherlands has pollution-sniffing bikes to monitor air quality on cycle routes

Indeed, pre-Sidewalk, Page's urban solutions included building a libertarian city-state on a ship with infamous and controversial tech founder Peter Thiel; installing a monorail with individual pods to better connect the University of Michigan; and installing a massive dome over a city for guaranteed weather, air quality and so on. Bonkers schemes can spark smart solutions, so there's nothing wrong with sketching out silly notions, especially when you've got hundreds of millions of dollars to play with as a co-founder of Google. The problem is finding a city willing to experiment on its own citizens.

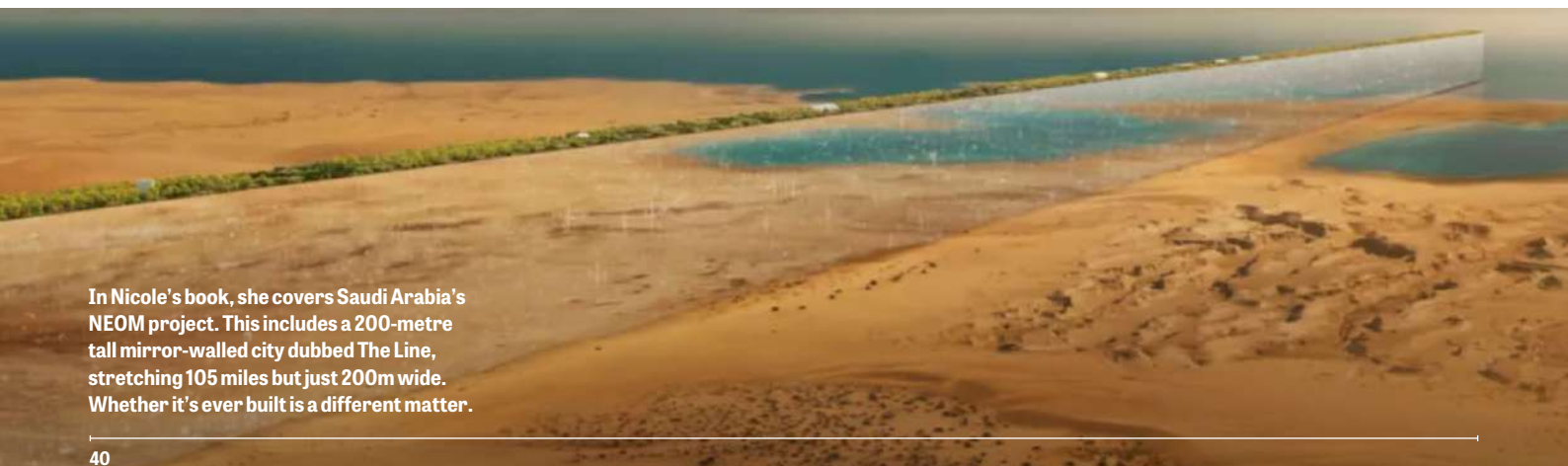
After nabbing former New York deputy mayor Dan Doctoroff as CEO, Sidewalk's first task was to set its employees building a document they dubbed the Yellow Book. This was essentially a heavily researched selection of urban solutions and futuristic visions to present to Page, including bathroom mirrors that analyse residents' faces for illness, a Yelp-style review system for police officers, and rewards for good behaviour based on detailed data collection. After a year of work, the plan was presented to Page, who seemed blasé about it, with the tech exec instead suggesting his own ideas, including buildings on wheels. Buildings. On. Wheels.

After 15 years of work, it was clear Songdo wasn't the draw that its creators had hoped

Sidewalk then started searching for a city, or part of one, that it could rebuild and gentrify. The edges of Denver, Colorado, and an old naval base in California were both considered, as were the emptying streets of central Detroit. O'Kane reports one consultant, Anthony Townsend, recalled a swathe of the fading Motor City being deemed suitable, but upon his own closer inspection, realised it would have required the bulldozing of a dozen historic churches. That's a tough sell even for Google.

That left Sidewalk as a city-fixing startup with no sandbox to play in – until Doctoroff got a phone call from a former colleague asking if the company would be interested in a project in Toronto. The Canadian capital had a small plot of land, just five hectares (12 acres), known as Quayside, a small slice of a wider regeneration plan tearing up ports and industrial warehouses along Lake Ontario. Toronto is short on land and short on housing, so Waterfront Toronto, as the project was known, was ideal for a smart new higher-density development from Sidewalk.

The team set to work, creating a 1,500-page document that included ideas such as covering the district with sensors to track everything from people to air quality, building everything out of wood, underground tunnels for autonomous mail delivery carts, driverless cars and heated paving slabs. Other ideas: robot trash collectors, automated meters to track waste and incentivise recycling, and dynamic roads that would respond to traffic patterns, switching a bike lane temporarily into a pedestrian walkway, for example. (And then watch all the cyclists yell at the pedestrians in their space.)



In Nicole's book, she covers Saudi Arabia's NEOM project. This includes a 200-metre tall mirror-walled city dubbed The Line, stretching 105 miles but just 200m wide. Whether it's ever built is a different matter.

According to reports at the time, Alphabet said it would build a system that would enable third-party sensor makers to be able to plug into the system, avoiding lock-in and a monopoly. And all the data that was collected would be managed by an independent trust.

Despite these safeguards, criticism came from many corners. One early critic was Jim Balsillie, best known as the one-time CEO of Research in Motion. He called the project "a colonising experiment in surveillance capitalism attempting to bulldoze important urban, civic and political issues". And then came the activists, led by local civics expert Bianca Wylie, who read an opinion piece by Doctoroff promoting the project and immediately took action, organising protests and making arguments to the government, media and even Sidewalk itself, attending their open-house events.

Sidewalk's own privacy team eventually quit the project. That included Ann Cavoukian, the former privacy commissioner of Canada and creator of the Privacy by Design framework that has been used with the EU's GDPR. She signed on to Sidewalk as a consultant, perhaps naively, but left after it became clear data would not be entirely stripped of personally identifiable information. "I imagined us creating a Smart City of Privacy, as opposed to a Smart City of Surveillance," she said in her resignation letter.

Even Waterfront Toronto's own board members quit, largely over Sidewalk's unrelenting push for more land, but also citing concerns about process, patent ownership and legal challenges; others were fired. It's hard to imagine allowing people to manage a city district when they have so many difficulties organising themselves.

By the end of 2019, the two organisations finally agreed on a draft proposal, after two long years of work. But six months later, the project was scrapped by Sidewalk, with Doctoroff saying Quayside no longer made sense as Covid hit and muddled up the works. "Unprecedented economic uncertainty has set in around the world and in the Toronto real estate market, it has become too difficult to make the 12-acre project financially viable without sacrificing core parts of the plan we had developed together with Waterfront Toronto to build a truly inclusive, sustainable community," he wrote.

Sidewalk at that time had a host of other projects, but it's perhaps best associated with two of them: Flow, a tool to battle traffic bottlenecks; and Link, which offered free local Wi-Fi in New York but surveilled streets with embedded cameras. Despite this, in 2020 Sidewalk itself was subsumed into Google.

While some of the technology suggested by Sidewalk sounds questionable – and stalkerish – the entire point of using a chunk of a city to build a smart test lab is to try new ideas. But it wasn't the tech that was the real problem with the Toronto project: it was Silicon Valley corporates clashing with democracy.

ABOVE **Cities must be sustainable and liveable, not smart**

BELOW **Saudi Arabia's NEOM project proposes a huge floating city**

Smart where it matters

We don't need smart cities. We need good ones. Liveable ones. We need sustainable ones. And we need them quickly. The UN expects the ratio of people who live in cities to climb from half today to two-thirds by 2050. But that won't happen evenly, notes Ricky Burdett, professor of urban studies at the London School of Economics and also Director of Urban Age, which runs global conferences on the future of cities. "If you look at a world map, where this urbanisation will happen is distributed completely unequally. Over 90% of it will occur either in the African continent or parts of Asia," Burdett told me, noting that cities such as Lagos in Nigeria and Dhaka in Bangladesh are growing at a rate of hundreds of thousands of people each year. That's an average of 70 people every hour of the day, adding to existing burdens on everything from roads to sewers to hospitals.

Technology can help, but it doesn't hold all the answers – especially in places without reliable energy grids or the budgets to fund such gadgetry. Burdett pointed to India's Smart Cities Mission, which had the admirable goal of providing core infrastructure and improving quality of life and planned to achieve that by adding smarts to 100 cities across the country. "The problem was that everyone came up with autonomous vehicles and smart traffic lights in cities where there were no sewers or housing or toilets," he said. "Wouldn't those come first?"

We know what makes a city nice to live in. We know what people value. No-one is asking for smart bins that ping a centralised dashboard, with data pulled into an AI decision-making system. But they are asking for clean streets and regular rubbish removal. If a sensor makes that happen without harming people through surveillance, that's fabulous. But first, make sure you've got an employee to go and empty that bin with a truck that won't get stuck in traffic.

NEOM will also feature a floating island resort in the Red Sea

Run WINDOWS 10 Forever

Not won over by Windows 11? Nik Rawlinson explains how to move Windows 10 to a secure virtual machine that you can keep using after the upgrade

YOU CAN TURN YOUR WINDOWS 10 PC INTO A VIRTUAL MACHINE WITHOUT PAYING A PENNY

If you're still using Windows 10, it won't have escaped your notice that Microsoft is keen for you to upgrade to Windows 11. Notifications have been popping up in Windows Update for some time, and recently users have been seeing full-screen adverts urging them to make the switch.

Yet users aren't exactly rushing to embrace the new OS. According to StatCounter figures from March 2024, Windows 10 is still running on 69% of all desktop computers, with Windows 11 trailing behind at 26.7%. For a free upgrade, that's a pretty low figure.

There's no single reason why more people aren't rushing to Windows 11. In some cases the new OS's hardware requirements are an obstacle – but we've heard from many readers that, even though their PCs are capable of running Windows 11, they simply don't want the upheaval of an OS upgrade when they already have Windows 10 running just the way they like it.

This is a perfectly respectable position; unfortunately, it's not one you can sustain forever. Windows 10 reaches the end of its support period in October 2025, after which regular security updates will cease and it won't be safe to continue using the OS.

But there is a way to keep using your Windows 10 desktop indefinitely, without having to worry about being cut off from updates. The secret is virtualisation: if you make a complete virtual copy of your existing Windows 10 installation you can install Windows 11 – or move to a new computer running the new OS – and keep up to date with the latest security fixes and feature updates, while retaining access to your familiar Windows 10 desktop and applications whenever you need them.

Is it right for you?

Modern CPUs include hardware virtualisation support, which in theory allows virtual machines to run just as quickly as your main OS. In practice, though, you'll need to divide your hardware resources between the host and guest operating systems – not only CPU power, but hard disk space, RAM and graphics memory. As a result, you may experience a performance drop under both operating systems when the virtual machine is running, even if you're not actively using it.

If you don't want to compromise on performance, another option is a dual-boot system. This is easy to set up, and lets each OS run at its full speed. However, it's less convenient, as switching between the two environments requires a reboot, and each system will still need its own disk partition. Plus, of course, running Windows 10 natively will leave you more exposed you to online risks once support ends next year.

In most cases, then, virtualisation is a better bet. Running one OS inside the other lets you use them simultaneously, and easily share files and hardware. And since the guest operating system is effectively sandboxed, your Windows 10 installation will be protected from online threats by the Windows 11 host. Depending on your hardware you may be able to get a performance boost by upgrading the RAM – and always get into the habit of shutting down your virtual machine when you're not using it, to return its resources to the host OS.

What do you need?

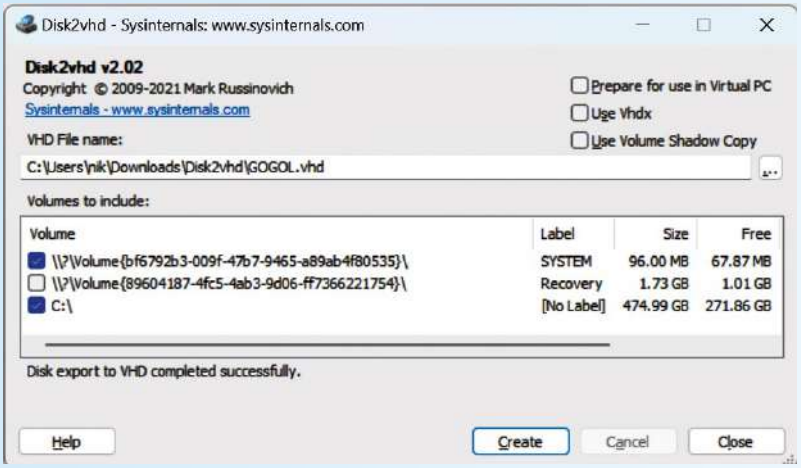
You can turn your Windows 10 PC into a virtual machine without paying a penny. All you need is some free software, sufficient room on your hard drive and an appropriately licensed copy of Windows (*see "Activation and licensing" on p45*). There are several tools that can be used for virtualising your existing Windows 10 machine: for this feature we'll use the free VirtualBox host from Oracle (**virtualbox.org**), but if you're experienced with professional virtualisation software you can also use VMware Workstation Player (**vmware.com**) or Microsoft's Hyper-V host, which is included with the Pro and Enterprise editions of Windows 8, 10 and 11.

The first step is to create a digital clone of the Windows installation that you want to virtualise. This can be done very easily with the Disk2vhd utility from Sysinternals (a Microsoft subsidiary). Download it from **tinyurl.com/359disk2vhd**, unpack the archive and right-click on the application disk2vhd64. You need to run it with elevated privileges, so select "Run as administrator" on the context menu. If nothing happens you might need to unplug devices or disable background apps that could be interfering with the process; in our case, it didn't work until we disconnected our external drives and shut down the pCloud sync client. Once Disk2vhd was up and running, we re-enabled pCloud and reconnected our external drives without issue.

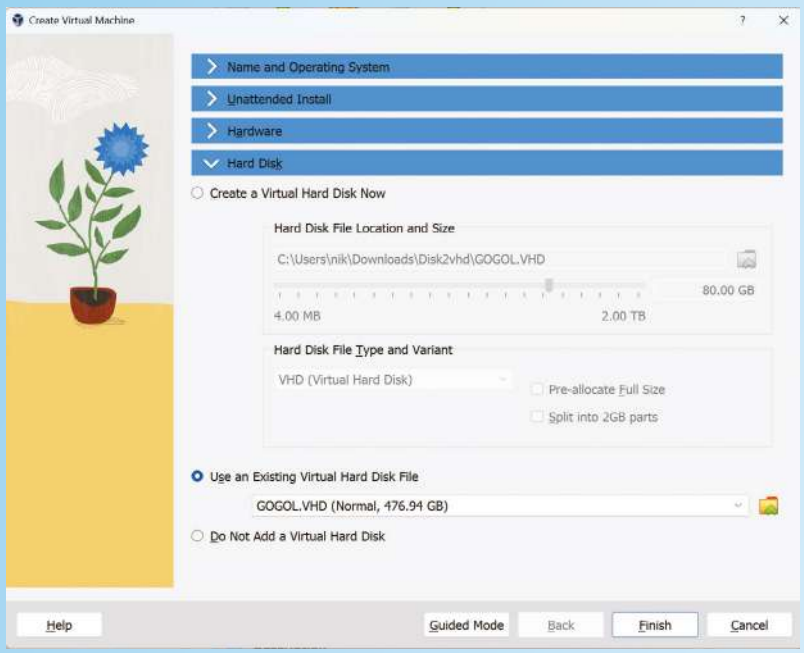
When configuring Disk2vhd, make sure all three options at the top of the window are unticked, then click the ellipsis button at the end of the "VHD File name" box and select a location for your saved file. You can leave it in the default location, in your Downloads directory, or store it on an external drive if you're short on space.

Now select the volumes you want to clone, using the tickboxes in the "Volumes to include" panel. At the very least you'll want to include your C: drive; we've also selected the System volume, which stores backup files for the OS, but we've chosen not to include the Recovery volume, which is used for reinstalling Windows in the event of a catastrophic failure.

Now click Create to start building the virtual hard drive image. You'll see a time appear in the bottom right



LEFT Disk2vhd can make a virtual clone of your physical drives, for backup or virtualisation



LEFT Setting up a shared folder simplifies sharing files between the host and guest OS

corner of the window: this is the anticipated completion time, not the time left to run, giving you a sense of whether it's worth your waiting around or leaving it to get on with the job unattended.

Install VirtualBox

Once Disk2vhd has finished cloning your working system, it's time to install VirtualBox, which you can get from **virtualbox.org**. You may also need to install the Microsoft Visual C++ 2019 Redistributable; if it's not already on your system when you run the VirtualBox installer, you'll be prompted to download it from **tinyurl.com/359vcredist**. You'll need to reboot when it's finished, at which point you can re-run the VirtualBox installer.

When the Virtual Box installer opens, step through the wizard. Click New on the main toolbar to create a new virtual machine, and give it a logical name such as "Windows 10 PC". Select the appropriate OS ("Microsoft Windows") from the Type menu, and the version from Version menu.

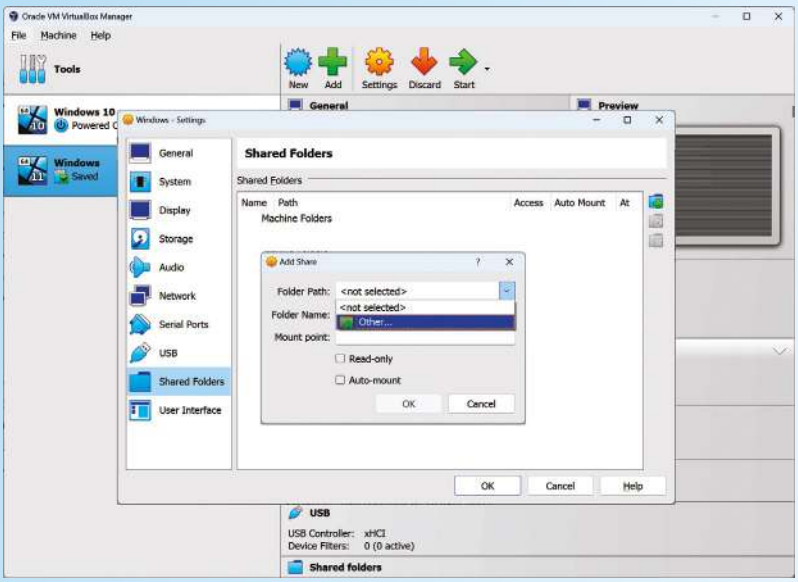
Next, click the Expert Mode button at the bottom of the window to unlock all of the setup options. Under Hardware you can configure how much of your PC's physical hardware you want to devote to the guest operating system: on our eight-core machine with 16GB of memory, VirtualBox suggested one processor core and 2,048MB of memory. That's not enough to run Windows 10 completely smoothly, but we decided to stick with it as we won't be using the archived operating system frequently. If you want a more powerful Windows 10 PC, drag the sliders to the appropriate positions, but avoid straying into the amber and red parts of each gauge if you can.

Now expand the Hard Disk section. Click the radio button labelled "Use an Existing Virtual Hard Disk File", then click the folder icon to the right of the text field. Click "Add" on the Hard Disk Selector toolbar, then navigate to and select the virtual hard disk you just created. Click Choose, then Finish.

VirtualBox will now boot your archived operating system, which should at this point work exactly like your main desktop. However, you may need to handle some minor initial configuration tasks: our virtual Windows 10 installation warned us that, because of changed security settings, we would need to change the PIN we used to log in. You may also be prompted to reactivate the OS (*see "Activation and licensing", opposite*).

And for convenience, you may want to set Windows 10 to share your personal folders with Windows 11: to do this, open the VirtualBox Manager, click the guest operating system, then click Settings. Click Shared Folders in the sidebar. Click the plus button on the far right of the panel to add a new folder, then click the Folder Path menu, then Other. Now navigate to the folder on your host operating system that you want to share with the guest environment. You might choose to create a folder inside Documents or Downloads specifically for this purpose, to limit what the guest OS can access. Once you've selected your location, click the option to Auto-mount, then click OK. The next time you start up the guest OS it will automatically be assigned a drive letter (such as Z:).

YOUR ARCHIVED OPERATING SYSTEM SHOULD WORK EXACTLY LIKE YOUR MAIN DESKTOP



LEFT Once you've created your virtual hard disk you can use it in VirtualBox

Boot straight into Windows 10

Once you've got your virtual Windows 10 installation working, you can upgrade the host OS to Windows 11 and fire up VirtualBox whenever you want to go back to your old Windows 10 setup. But what if you want to carry

on using the Windows 10 installation as your primary operating system? In that case you can configure your computer to load up the VM in full-screen mode as soon as the host OS launches, leaving Windows 11 entirely hidden in the background.

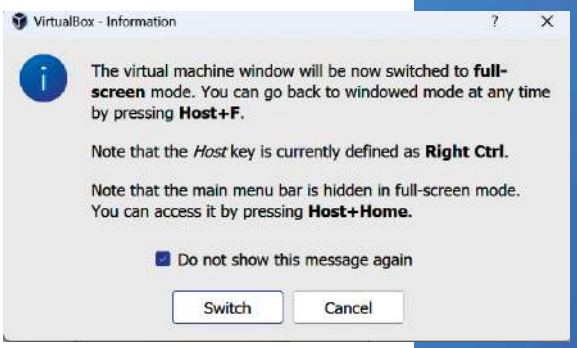
To achieve this, let's first set the VM to start up in full-screen mode. This requires installing a set of add-on features called Guest Additions, which is very easy to do: just start your VM, then click Device on the VirtualBox toolbar, followed by Insert Guest Additions CD image. This loads a virtual CD into the guest machine's virtual optical drive. Open the VM's File Explorer and navigate to the D: drive, then launch VBoxWindowsAdditions.exe. Wait for the additional features to install, then reboot the VM.

You can now enter full-screen mode by holding down the right Ctrl key and pressing F (use the same combination again to exit full-screen mode). Tick the box beside "Do not show this message again" so the alert about keyboard shortcuts doesn't delay entering full screen in the future, then click Switch.

Now press the right Ctrl key + Home to call up the floating VirtualBox menu; hover over View and click "Auto resize Guest Display" to set the resolution of your virtual machine to match that of your host monitor. Now press the right Ctrl key + Q to show the Close dialog, leave "Save the machine state" selected and click OK. This will save the current state of your guest operating system, so that next time you start the VM, it will open with the same screen settings.

The last thing to do is set the VM to launch automatically when the system boots. There are several ways you might achieve this. Here's one: when you get back to the VirtualBox Manager, make sure your Windows 10 installation is selected, then click Machine (on the top menu), followed by "Create Shortcut on Desktop".

Switch to the Windows desktop, press the Windows key + R to open the Run dialog and enter "shell: startup". Copy (or move) your new shortcut from the desktop to the window that opens; now, each time your PC boots, the VM will start up automatically.



LEFT Suppress this alert so it doesn't interrupt your switching to full screen in the future

ACTIVATION AND LICENSING

Windows isn't free software. You may not have paid for it directly, but when you buy a new PC with Windows preinstalled the price includes a licence to run the operating system. Normally this will be what's called an OEM (Original Equipment Manufacturer) licence, meaning it's tied to the specific hardware. In other words, it allows you to run Windows on that specific computer, but not to move it onto another machine.

This has both practical and legal implications. If you've ever performed a major hardware upgrade on a desktop PC – such as replacing the motherboard – you may have found that Windows thinks it's no longer running on the same machine, and requires you to reactivate the OS. Similarly, when you move Windows 10 from physical hardware into a virtual environment, it may require reactivating.

This should be a minor hurdle. You may be able to activate the virtualised OS by simply following the onscreen prompts; if that doesn't work, open the Settings app in your virtual Windows 10 machine, go to System | Activation | Troubleshoot and run the Activation Troubleshooter. As long as you're logged into a Microsoft account, Windows should give you the option to deactivate your old physical Windows 10 installation, after which you'll be able to activate the new virtual installation. In the worst case, you can use Windows 10 indefinitely without activating it, although a few personalisation features will be disabled.

Even if you activate successfully, however, be aware that your Windows licence doesn't technically permit you to continue using your virtual Windows 10 machine after upgrading the physical installation to Windows 11. To fully cover your continued use of Windows 10, you can buy a new licence through the *PC Pro* Store (**store.pcpro.co.uk**), costing £49.99 for Home or £69.99 for Professional. When you do this, you'll receive a new digital product key; you can enter this into your virtualised Windows 10 system by opening the Settings app, navigating to the Activation page and clicking on Update product key.

Alternatively, you can use the Windows 10 Media Creation tool to download an ISO of the latest version of Windows 10, and use VirtualBox to create a clean, fresh installation of the OS, entering your new product key when prompted by the Windows installer.

Run your own personal cloud

Fed up with storage quotas and monthly subscriptions? Darien Graham-Smith finds out how to turn a Raspberry Pi into your own private cloud server

In an age when we're all living and working across multiple devices and locations, cloud storage is indispensable. Unfortunately, it costs money – at least, it does once you go beyond the limited quotas offered by the likes of Box, Google Drive and OneDrive. If you're feeling squeezed by the storage limit on your current cloud plan and aren't eager to take on yet another subscription, it's easier than you might think to set up your own personal cloud, with no fees and no storage caps.

There are some downsides to running your own cloud. Obviously you have to provide the hardware yourself. However, this doesn't have to be expensive – you can use an old PC, an existing NAS or – as we'll explore on these pages – a dirt-cheap Raspberry Pi board.

You also have to look after your own data, and take steps to minimise the risk of losing files in the event of a burglary, fire or hardware failure. We'll talk about some of these below.

Other than that, though, it's all upside. With your own cloud server you can use as much storage as you like, while taking advantage of familiar features such as automatic syncing, on-demand downloads and secure sharing. What's more, you can keep all your data in your personal possession, rather than entrusting it to a global megacorporation. So what are you waiting for?

Picking a platform

The hardware requirements for a cloud server are very low. The synchronisation service runs in the background and requires minimal CPU power; the main requirement is that the host should be kept switched on and online at all times, to keep your cloud files accessible and up to date.

As for the software, there are a few options to choose from, but we like the open-source Nextcloud package (**nextcloud.com**) because all the most important features are available to users for free, with no restrictions on devices or storage. It also has extensive online documentation available at **docs.nextcloud.com**, and a vibrant user community that can help you out if you run into any questions or problems.

The Nextcloud server runs on Linux, but this doesn't mean you can't use it on a Windows PC or a Mac. On the Nextcloud website you'll find links to downloadable VM and Docker images that let you run the software in a self-contained Linux environment, with all the requisite OS components.

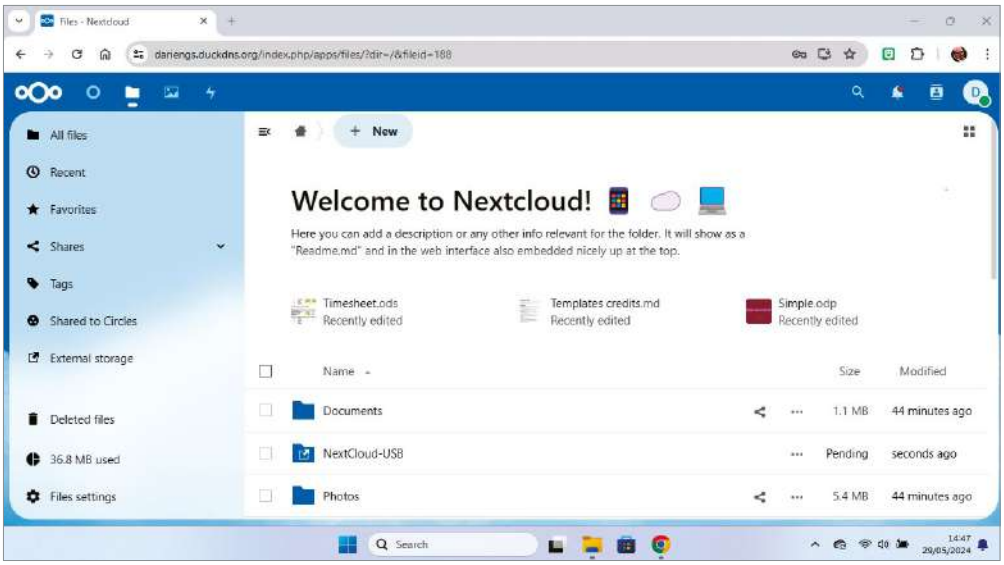
For our purposes we'll focus on the Raspberry Pi. It's an ideal platform for Nextcloud, as it runs Linux natively, and its tiny power requirements mean

you can leave it on 24/7 with minimal fan noise or energy consumption.

Installing Nextcloud

There are several methods you can use to get Nextcloud onto your Pi. The publisher offers downloadable virtual machine and Docker images, or you can build and configure the platform yourself from source code. There are also a few Pi-specific community distributions, such as NextcloudAIO (**tinyurl.com/359aio**) and NextcloudPi (**nextcloudpi.com**), that streamline the process. Another option is to use the DietPi OS distribution (**dietpi.com**), which includes an automatic installation script for Nextcloud.

Probably the easiest way, though, is to use Snap. Snap is a container-type software distribution framework



You can keep all your data in your personal possession, rather than entrusting it to a global megacorporation

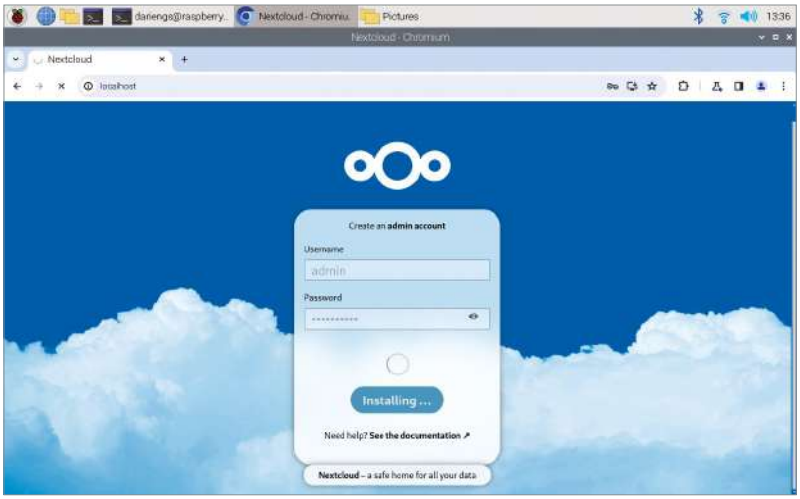
created by Ubuntu developer Canonical that can be used to deploy Nextcloud, along with all the web server and database components it relies on, with just a couple of terminal commands. You can run it on a fresh installation of Raspberry Pi OS, or on a Pi system that's already up and running – although we recommend you don't use a machine that's already running a web server, as you'll need to configure this to coexist with Nextcloud's own web interface, which could get tricky.

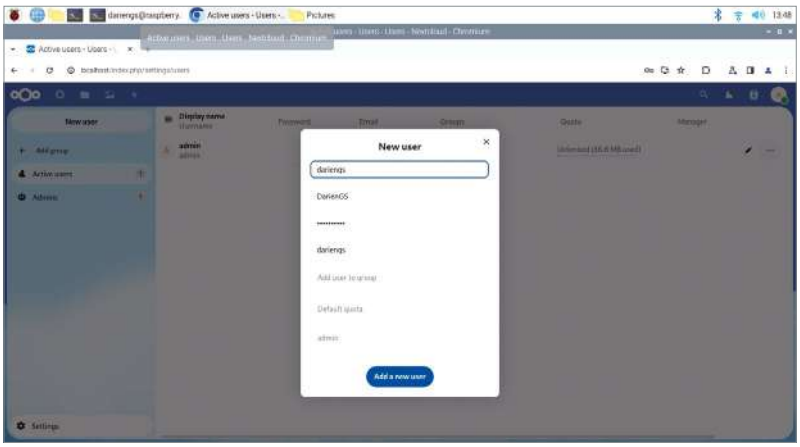
We've just one other caveat, which is that the Snap installer for Nextcloud isn't currently compatible with the Raspberry Pi 5. An update will probably come soon, but the Pi 5 is overkill for a simple server role such as this anyway: we found a Raspberry Pi 4 worked perfectly, and even older boards should be able to run Nextcloud satisfactorily.

Whichever version of the Pi you choose to use, the first step is to install the Snap framework itself, which you can do by opening a terminal window on your Raspberry Pi and entering:

sudo apt update
sudo apt install snapd

Press Return when prompted to approve the installation. Once this has finished, reboot your Pi, then reopen the terminal and enter these two further commands:





TOP Nextcloud is free, with no restrictions on devices or storage

ABOVE RIGHT Nextcloud runs on Linux, but you can also use it on a Mac or a Windows PC

RIGHT Nextcloud's interface is friendly and easy to use – once installed

sudo snap install core
sudo snap install nextcloud

After a minute or two of downloading and installing, you should be returned to the terminal prompt; your Nextcloud server is now ready to use.

You can confirm this by opening a web browser on your Pi and entering "localhost" as the address. You should see a Nextcloud welcome page, prompting you to create an administrative username and password. You can use your own name for this, but we recommend you create a generic administrative account now, and set up a personal account for yourself later.

Once you've entered your chosen credentials, click Install and Nextcloud will spend a few more minutes completing its initial setup. You'll then see a welcome screen prompting you to install various Recommended Nextcloud apps; for now we're just interested in cloud syncing, so we suggest you click Skip. You can always explore these add-ons later.

You'll now be taken to the Nextcloud Hub, showing some example "Recommended files" that have been automatically created and placed in your administrative user's cloud space. Click the little folder icon at the upper left of the window (the word "Files" appears under it when you hover) to switch to the main file manager view. From here you can browse, upload and download files, and generally explore your new cloud storage space.

There's just one more thing to remember: this isn't actually your personal space, as you're still logged in as the administrative user. To set up your own profile, click on the profile icon at the top-right of the window, then select Users from the drop-down menu to switch to the user settings page. Click "New user" at the top of the left-hand pane, then fill in the form that appears. For security reasons we recommend you don't make yourself an administrator, and you probably won't want to give yourself a storage quota (although you might choose to do that for any friends or family you invite onto your server). Once you've entered your desired settings, click the "Add a new user" button at the bottom to create your new account. Note that you'll still be logged into the Nextcloud Hub as the administrative user until you manually log out of the server and log back in with new credentials.

Nextcloud has the ability to automatically generate an SSL certificate for your domain using a free service

Enabling remote access

Now we need to make it possible to access Nextcloud from a different computer. If you're connecting from another machine on your home LAN then you could do this by entering the Pi's local IP address or internal hostname into a web browser.

However, this won't work over the internet. To enable remote connections you'll need to know the external IP address of your router. You can normally find this address in the router's administration interface, and while you're there, you'll also need to configure the router to forward inbound connections on ports 80 and 443 to your Pi. The precise process for this will depend on your router make and model, so check the documentation for advice.

Once you know your external IP address, you can use a free dynamic DNS service such as DuckDNS (**duckdns.org**) to register a memorable name for it – I went with dariengs.duckdns.org. It's strongly recommended that you also set up this domain for secure access via HTTPS, to ensure no-one can snoop on your files when you're uploading or downloading them. This is gloriously simple to do, as Nextcloud has the ability to automatically generate an SSL certificate for your domain using the free Let's Encrypt service.

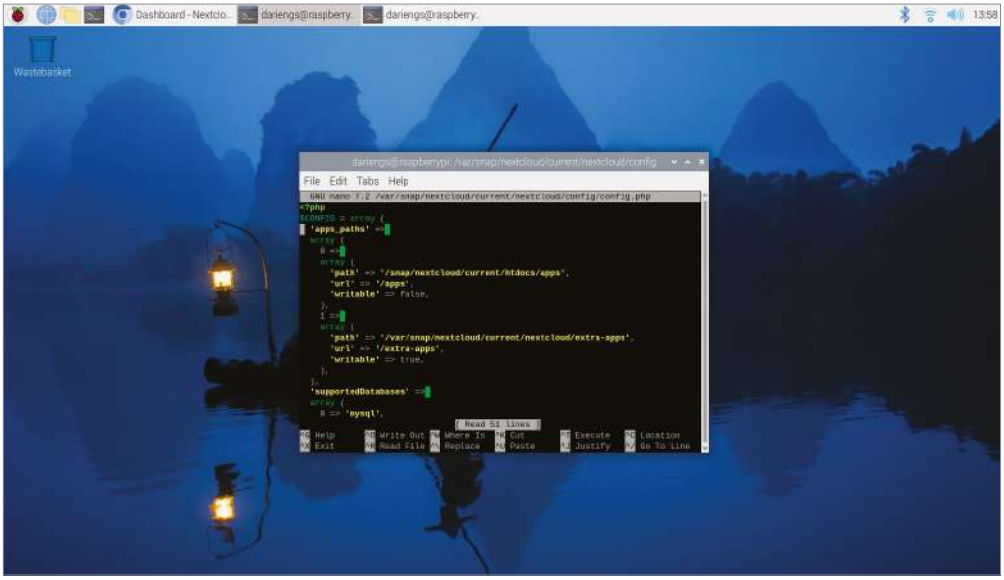
The only slight complication is that the Linux sudo command doesn't know where to find this tool inside the Snap installation, so when you run it you need to include an argument that tells it to search within your current path. The full command you need to enter is:

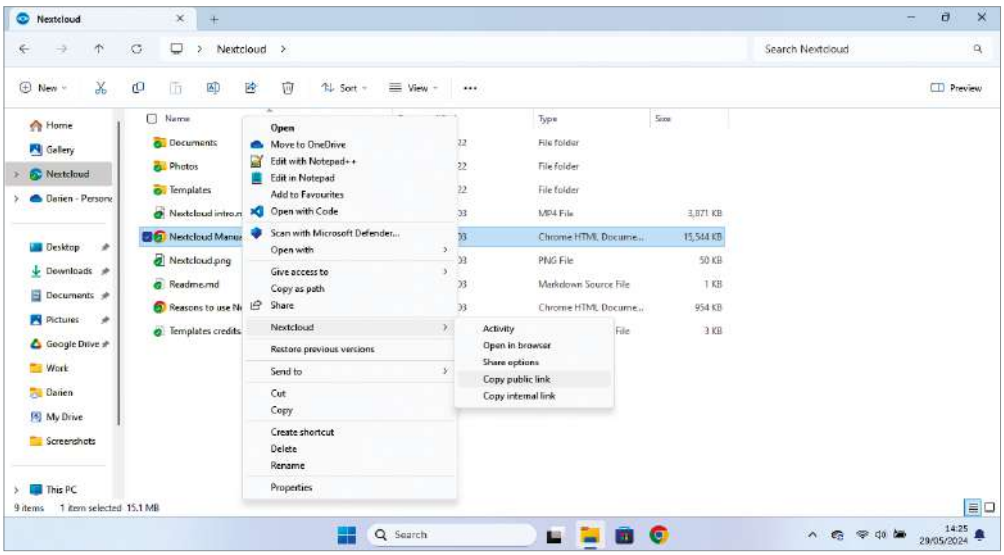
```
sudo -E env "PATH=$PATH" nextcloud.enable-https lets-encrypt
```

When you run this command you'll be prompted to confirm that you accept the Let's Encrypt terms of use, and that you've correctly set up your domain name and port forwarding. You'll then be asked to provide your email address and domain name; after a little cogitation the process will complete and you should immediately be able to securely access your Nextcloud server from anywhere by browsing to – for example – https://dariengs.duckdns.org.

There's just one last hurdle: the first time you try this, you'll be faced with a warning that you're connecting via an untrusted domain. For security reasons, Nextcloud only allows access via preauthorised IP addresses and domains. To enable connections via your external IP address or dynamic domain name you need to hop back onto your Pi and edit a configuration file. You can do this using any text editor you like; we'll use Nano, by entering the following line at the Pi's terminal:

```
sudo nano /var/snap/nextcloud/current/nextcloud/config/config.php
```





BELOW You can edit the config file using any text editor you like

BOTTOM Your synchronised files can be viewed in an Explorer window

When the file opens, scroll down about two pages until you find the following lines:

```
'trusted-domains' =>
array (
 0 => 'localhost',
)
```

You now need to add your external IP address and/or domain name as additional entries in the array – so, for example, if my external address were 140.228.73.229, I'd want the relevant section of the file to look like this:

```
'trusted-domains' =>
array (
 0 => 'localhost',
 1 => '140.228.73.229,
 2 => 'dariengs.duckdns.org'
)
```

Note the commas that separate configuration entries. Once you've added the necessary lines, save the file and exit the editor: if you're using the Nano editor, you can do this by pressing Ctrl+x to quit, then hitting Y followed by Return to save the updated file.

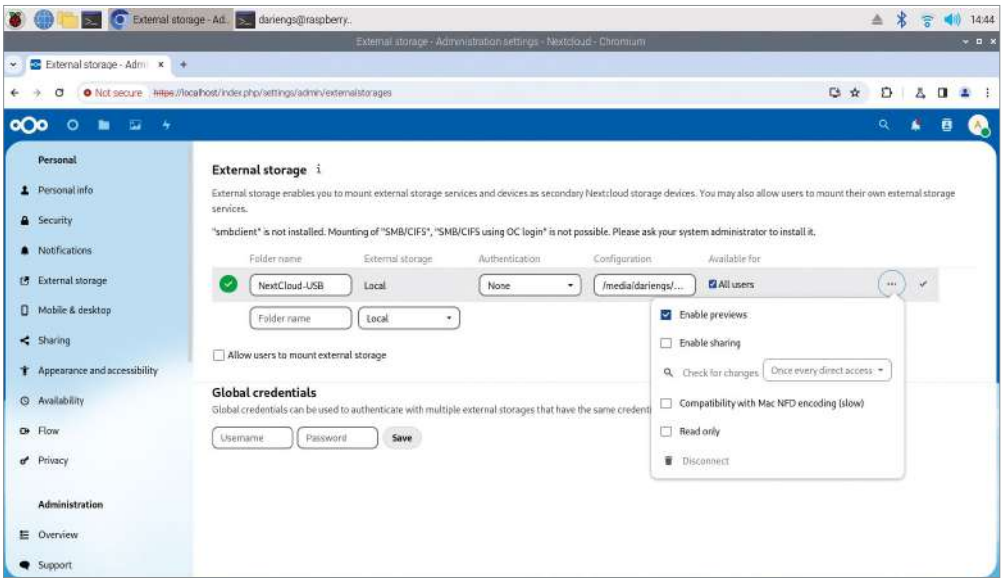
Now switch back to the computer you were trying to access Nextcloud from and hit Refresh on your web browser. This time you'll be prompted to log in, using the personal username and password you set up previously. You'll see the Nextcloud Hub welcome page again, just as on the Pi, and you can click on the Files icon to access your personal cloud file space.

Installing the desktop client

Naturally, you don't want to be limited to browsing your files via the web client; you want to view and edit them directly on the desktop, and to have them sync in the background. To set this up you need to install a small client utility on each system you want to sync, just as you would with Google Drive or Dropbox.

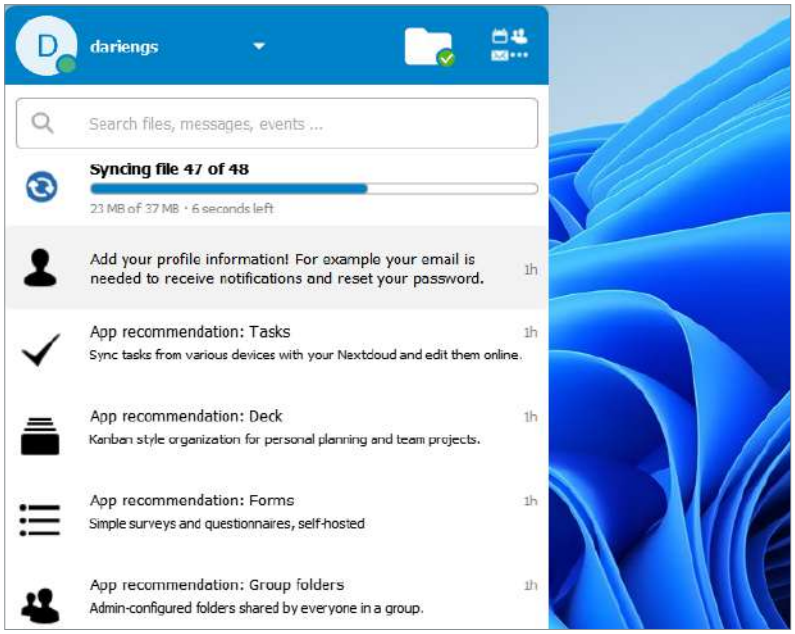
You can download the client software for Windows macOS and Linux from **nextcloud.com/install** – click Download for Desktop to view the installers. For mobile access to your files, there are also companion apps available in the iOS App Store and Google Play.

The client software installer for Windows is mostly self-explanatory – just click through it, then hit Finish when you're done and reboot your PC. When Windows restarts, you should see a new Nextcloud icon on your desktop; double-click it and you'll be prompted to authorise this computer to connect to your Nextcloud



ABOVE Nextcloud allows you to use an external disk for your storage

RIGHT To sync your files, simply install a small client utility on each system



Cloud syncing with NAS

Most modern NAS platforms include a personal cloud server component. Asustor calls its cloud platform EZ Sync; on Synology it's Synology Drive, while Qnap has its own offering called Cloud Drive. If you already have a NAS appliance then using one of these services for your cloud storage and synchronisation needs is probably a no-brainer – you don't need any extra hardware or software, and you can use as much space as is available on your NAS volume.

If you're thinking of buying a new appliance primarily for online storage and syncing, there are a few cloud-focused NAS options to consider. The WD My Cloud Home is offered in a range of capacities from 2TB to 8TB, with prices starting at just £118 (see tinyurl.com/359mycloud), while Synology's BeeStation comes in a single 4TB configuration for £250 (tinyurl.com/359beestation). These prices are cheaper than a general-purpose NAS, but the devices aren't as versatile, lacking features such as media server or IP camera management capabilities.

It's also important to note that the My Cloud Home and the BeeStation are both single-drive devices. You'll need to use them in combination with some sort of backup solution, because otherwise if the disk dies, your data is gone for good. If you like the WD route, consider the My Cloud Home Duo, which uses a pair of mirrored disks for failure protection.

Even if your NAS is using a two- or four-disk RAID configuration, remember that your files aren't truly backed up if they're all in one physical location. Hopefully you already have an offsite backup system in place for your precious data; if you don't want to pay for cloud storage (which is, after all, the whole point of this feature), consider periodically copying your most important files onto an external hard disk, and storing it in a different room – or, ideally, a different building.

account. Click "Grant access" and you're all set; from now on, Nextcloud will run continually in the background, keeping your files synchronised with the Pi.

To find them, just open any Explorer window; you'll see a new shortcut to Nextcloud in the left-hand pane, which you can click on to view your synchronised files. If you right-click on an item inside your Nextcloud folder you'll see a new Nextcloud submenu, from which you can get information about a file or folder, share it with another Nextcloud user, or get a public link that anyone can open.

If you don't want to synchronise all files from your cloud server, you can either double-click on the Nextcloud icon again or click on the new Nextcloud icon in your system tray. Then click on your name at the top of the window that opens, and select Settings from the drop-down menu. A window opens showing a map of your Nextcloud storage space; just untick any items or folders that you don't want to sync with this computer.

You can also enable on-demand downloads from this window, by clicking the "…" icon at the right of this window and selecting "Enable virtual file support". With this feature active, Nextcloud will show the contents of your synchronised folders in Explorer, but to save space it will only download items when you access them. Context menu items allow you to always keep specific files on the device, or purge cloud files to free up space.

There are plenty more settings and options to explore, but your basic cloud sync and sharing system is now fully up and running. All you need to do now is install the desktop client on any additional computers you want to keep in sync.

External storage

Since we've installed Nextcloud via Snap, our cloud files will be, by default, stored inside the Nextcloud container on our Raspberry Pi's microSD card. This might suit you fine, but depending on the type and capacity of card you're using you might find that access is slow, and you quickly run short on space.

You can improve matters by storing your cloud files on an external USB drive instead. While it's technically possible to move your entire Nextcloud data folder, this isn't supported; a cleaner option is to configure an external disk as a subfolder inside Nextcloud, and use this for your everyday storage. To do this, we first need to allow the Snap container to access removable media, by entering this command:

sudo snap connect nextcloud:removable-media

Now we can set up Nextcloud to make the external storage available for cloud files. Just for a change, this doesn't have to be done from the terminal – you can configure it from the Nextcloud web interface, as long as you're logged in as an administrator. First, though, plug in the USB drive you want to use, and check that it's formatted using a file system such as FAT32 that can be natively read and written by the Pi. Create a new folder on it called Nextcloud.

Now open the Nextcloud Hub in your browser, click on the administrator user profile icon at the top right of the page, and select "+ Apps". In the main pane on the page that opens, scroll down to "External storage support" and click the blue "Enable" button to its right. If prompted, enter your password to approve the change.

Now click again on your profile icon and select "Administration settings". The settings interface will open; in the left-hand pane, scroll down to the "Administration" section and click "External storage". (Don't click the link of the same name in the upper Personal section.)

You should now see the External storage configuration page. Click the dropdown box labelled "Add storage" and select "Local"; this will cause some new text-entry boxes to appear. In the leftmost field, labelled "Folder name", enter something like "Nextcloud-USB". Leave Authentication on None.

Under Configuration, enter the full Linux path to the folder you created on your USB drive. In my case this was /media/dariengs/USB-DISK/Nextcloud; yours will be something similar, with your own username and drive label. If you don't know these details, right-click on your USB drive on the Raspberry Pi desktop and select Properties from the context menu to see the name and location of your disk.

If you plan to host multiple users on your Nextcloud server, you can tick the box to make the external drive available to all users, or use the dropdown to select who can access it. The three-dots menu to the right of this includes a few advanced options you might want to look at, including the ability to allow sharing from your external location. When you're happy with your settings, click the tick icon beside it to confirm the changes.

Now when you go back to the Files view you should see a new folder inside your Nextcloud space called "Nextcloud-USB" (or whatever you chose to call it), which corresponds to the nominated folder on your external drive. Note that the Nextcloud desktop client doesn't synchronise external storage spaces by default, but you can set it to do so from the client settings page on each computer you want to sync.

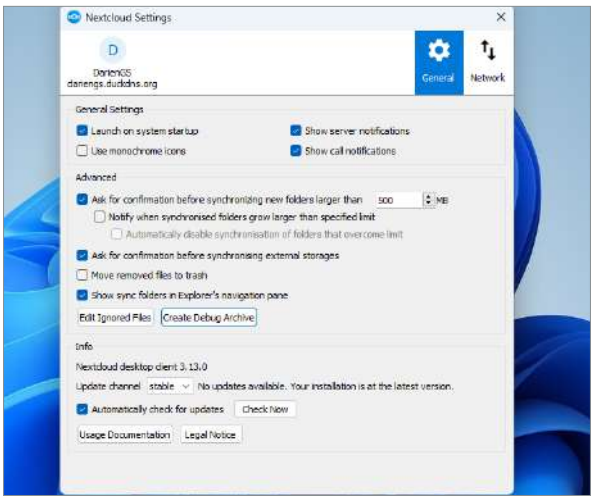
For convenience you might also like to delete the shortcut to your Nextcloud folder in the Windows File Explorer, and replace it with one that goes straight to your USB folder, so you know all your files are in one place.

Next steps: RAID storage

Storing your cloud files on a single microSD card or USB drive isn't ideal. If the card gets corrupted or the disk dies then the files in your Nextcloud space could be lost, although copies may still be available on any connected machines.

If you don't want to take that risk, consider connecting a pair of matching USB drives and configuring them as a RAID1 (mirrored) array. Space doesn't permit us to go into the process of configuring two disks as a single volume in Linux, but online guides can take you a long way. And remember to pay attention to the power requirements of your drives; you might need to use a powered USB hub or a high-wattage supply for your Pi to enable them both to operate reliably.

If you plan to host multiple users on your Nextcloud server, you can make the external drive available to all users



ABOVE There are lots of settings and options to explore

6 ethical reasons to choose TelephoneSystems.Cloud

We've already shown that its product is more than up to scratch, but now we go behind the scenes to find out the softer, ethical reasons to choose this UK-based company

PC PRO RECOMMENDED

TelephoneSystems.Cloud earned five stars and a *PC Pro* Recommended award in Dave Mitchell's round-up of VoIP services two months ago (*see issue 357, p100*), primarily due to the quality of its offering. But that's not the only reason why businesses choose other businesses to work with: you also need to find like-minded souls. Here, we look at the "ethical" reasons to choose this Staffordshire-based firm.

1 Ethical fixed prices

We're all familiar with the promise of "half price for six months" to attract new business, of deals that look too good to be true. When you're with TelephoneSystems.Cloud, the prices you see on the website are what you will pay. All users cost £11 exc VAT per month, which includes a huge number of features (see the box on the right). With no annual contract price increases, you always pay the new customer price shown on the website.

2 No contract lock-in

With TelephoneSystems.Cloud, there's no contract. That means you're free to add or remove users each month to match your business needs. And rather than tie companies to its service by force, TelephoneSystems.Cloud believes that its excellent value and service, together with total transparency over costs, means that you won't want to leave. So, you know there won't be a sneaky price increase while you're trapped in a contract, because there isn't one.

3 No hidden fees

Choose TelephoneSystems.Cloud and you'll get all the support you need included in the month's fee for configuration and installation, with the help of its experienced team based in Stoke-on-Trent. TelephoneSystems.Cloud configures everything in the cloud, exactly as you want it, and the support team will make sure it's working perfectly – so no hidden extras or small print that's impossible to understand.

4 Fanatical about support

One of the company's promises is that it will help to resolve problems, even if they aren't caused by TelephoneSystems.Cloud. And if you find someone in the support team who you've built a rapport with, then you can go back to that person to ensure continuity. To quote managing director Alastair Bates: "Our team is friendly, approachable and will always give you straightforward, honest answers."

5 Right solution for your business

You can use the quote wizard on the website to create exactly the right mix of features for your needs or, if you prefer, you can call and tap into the team's expertise at no extra cost. Their promise: to try and understand your business objectives so that they can provide the right solution, not just any solution. They are always happy to talk you out of an additional service they don't think you need!

6 Profit-sharing scheme

One of TelephoneSystems.Cloud's promises is that it treats its customers, staff and employees with the same respect. Not only does that mean that customers get fixed prices, but suppliers are paid on time and its hard-working team gets a share of the profits. Oh, and it pays its taxes too!

Free features for everyone

Here's what you get for £11 exc VAT per month per user...

- ✓ SOFTPHONE MOBILE APP
- ✓ SOFTPHONE DESKTOP APP
- ✓ CALL ANALYSIS REPORTING
- ✓ AUTO-ATTENDANT
- ✓ CUSTOM GREETINGS
- ✓ VOICEMAIL TO EMAIL
- ✓ ADVANCED HUNT GROUPS
- ✓ CALL DIVERT
- ✓ SIMULTANEOUS RING
- ✓ CALLER ID
- ✓ LIVE BUSY STATUS
- ✓ CLICK TO DIAL
- ✓ HOLIDAY AND TIME SCHEDULING
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Asus Vivobook S 15 OLED Copilot+ PC

A strong debut for both Copilot+ PCs and the Qualcomm Snapdragon X Elite chip for Windows

PC PRO RECOMMENDED

SCORE ★★★★☆

PRICE £1,083 (£1,300 inc VAT)
from uk.store.asus.com

Microsoft decided not to deliver Windows 12 this year, but arguably it's offering something even better: Copilot+ PCs. These still run Windows 11, but as the name alludes to they're capable of running Microsoft's Copilot AI directly on the silicon. To be precise, that means neural processing units (NPUs) that are capable of handling 40 trillion operations per second (TOPS). Otherwise known as one heck of a lot.

Right now, Qualcomm is the only manufacturer shipping a processor – technically we should call it a system on chip, or SoC, but there are quite enough TLAs to deal with so let's not be pedantic – capable of 40 TOPS. In fact, it has four such chips available to manufacturers, all of which are rated at 45 NPU TOPS. We summarise them in the table on p55.

As you'll see from our summary of the other Copilot+ PCs on p54, the "budget" Copilot+ PCs come with either the X Plus or the lowest model in the X Elite range: the X1E-78-100. But it's obvious that you'll get a boost by moving up the range (as is always true with processors), because the two top-most chips provide a dual-core boost and the very top chip, the X1E-84-100, also has significantly higher firepower.

Qualcomm's monopoly will be short-lived. As we cover in our round-up of Computex 2024 (*see p12*), both AMD and Intel have announced chips compatible with Copilot+, so expect more choice in the coming months. If you're buying for a business rather than as a consumer, it looks like you'll have to wait until autumn for Copilot+ PCs; right now, this is purely a consumer launch.

"Almost every app I tried that hadn't been recompiled or built from the ground up for ARM ran well under Microsoft's new emulator"

BELOW The Vivobook S 15 is an extremely promising start for Copilot+ PCs

There are two other more mundane requirements to hit the Copilot+ PC benchmark: the PCs must have at least 16GB of DDR5 or LPDDR5 memory, and a minimum 256GB SSD.

Microsoft's Rosetta: Prism

Anyone who has bought or used a previous Windows PC based on ARM processors – for this is a radical shift in architecture, as Jon Honeyball discusses in his column this month (*see p110*) – may well be wondering about compatibility. And the good news is that it's generally excellent. I hit problems when playing games, but almost every app I tried that hadn't been recompiled or built from the ground up for ARM ran extremely well under Microsoft's new emulator, Prism. To give one niche example, that includes DisplayCal – testing software that I use to measure a

panel's colour coverage – and this software hasn't been updated in years.

Microsoft claims that Prism is as efficient as Rosetta 2, Apple's own successful emulator, and that x86 apps will run twice as fast on Snapdragon X Elite chips as they would on previous-generation Windows on ARM devices. That's a carefully phrased claim, but the point stands: unless it crashes, most people won't spot that the software they're running is in emulation.

Why buy a Copilot+ PC?

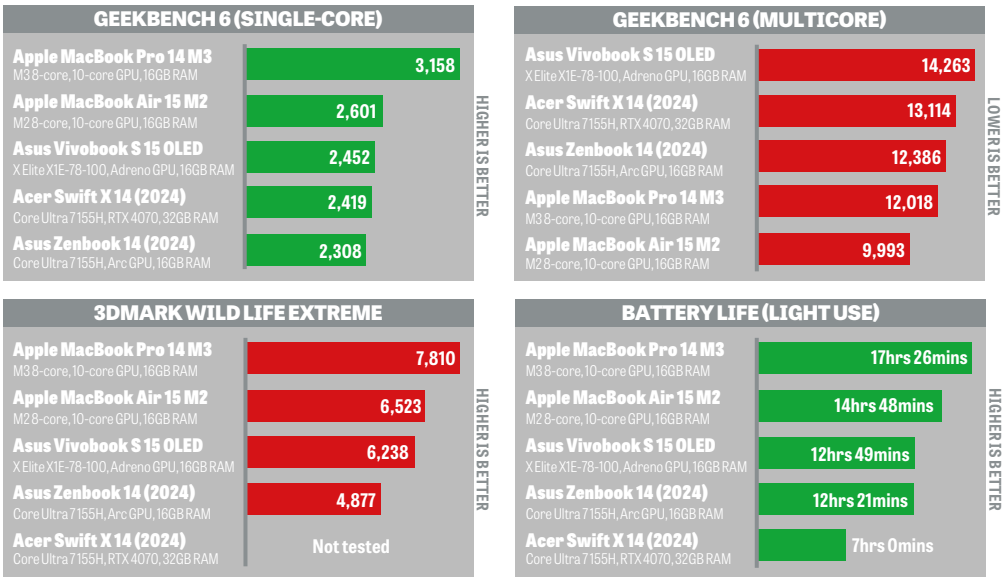
Six features will be exclusive to Copilot+ PCs, all of which will run on the NPU rather than in the cloud. The most controversial is Recall, which you can read about on p10 of this issue. There's no doubt that Recall has the potential to be a fantastic aide memoire – it doesn't only take snapshots of what was onscreen, but allows you to ask natural language questions (such as "What do I need to buy on the way home?" and it will search for relevant requests, for example in WhatsApp if you've given it permission to look at it) or bring up images based on a keyword.

There are three image-based features, and Cocreator is the most interesting. This is built into Paint, and allows you to augment the usual text prompts (such as "Boat in stormy weather" in my example to the right) with your own drawings or others that you've sourced. It's based on OpenAI's DALL-E technology, and while the ability to create images from text is hardly new, this is a unique way to take ideas from inside your head and turn them into actual pictures. And to then iterate on them; for example, you can add a tree and that will be added to the final result.

Image Creator is self-explanatory – create an image from your text prompts – but I enjoyed playing with Restyle Image. This "applies artistic styles to existing photos with AI-powered edits". I took a photo of myself with bushes and trees in the background, and then told it to apply a few of its preset filters – Anime, Pixel Art and Renaissance to name three. They work superbly, and you can customise the prompts as you wish. Both Image Creator and Restyle Image sit in the Photos app.

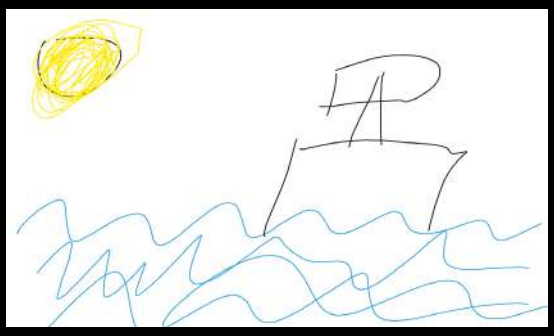
Microsoft has also enhanced its Windows Studio Effects, its video enhancement tool – think background blur, fake eye contact – that we've already seen on laptops with less powerful NPUs (such as Intel's Core Ultra chips). The two new features are the self-explanatory portrait light and three weird creative filters. Illustrated makes it look like you've been drawn, Water Colour gives the faintest hint of this painting style, and Animated adds a vague cartoonish effect. I'm yet to be convinced of their utility.

Where things potentially get more interesting is Microsoft's Live Captions, which – Microsoft claims – "can instantly translate any live or pre-recorded video in any app or video platform from 44 languages into English". From my early experiments this works well, but I would be interested to hear from readers who are fluent in another language and have tried it (email editor@pcpro.co.uk).



Cocreator in action

One of Copilot+ PCs' most interesting features is Cocreator, where you mix text prompts with your own sketches. Here, as they say, is one we made earlier: my text prompt was simply "Boat in stormy weather". You can see my original sketch below with the AI-assisted versions underneath.



ABOVE Our original high-quality, extremely detailed sketch

ABOVE An AI-produced version on medium creativity settings

ABOVE Choose maximum creativity and the difference is stark

First across the line

I expect to review dozens of Copilot+ PCs over the coming months, but the honour of being first goes to the Asus Vivobook S 15 OLED. It's an interesting opener as Vivobook is Asus' mainstream consumer laptop brand, with Zenbook (such as the Zenbook 14 OLED I review on p58) being its premium offering. That means compromises here, as we shall see, but make no mistake: this is a high-quality machine.

For instance, it uses an all-metal chassis, and while its brushed aluminium exterior is plain and rather boring, it's well made. I wouldn't hesitate to whip it out in a business meeting. What it lacks is any sense of luxury: while it's hardly fat, tapering from 15.9mm at the back to 14.7mm at the front, it doesn't have the eye-catching svelteness of a premium laptop.

Usually Asus will supply its laptops with a bunch of different specs, but it's playing it safe with its first Copilot+ PC and only offering one model. You get 16GB of embedded memory, a speedy 1TB NVMe SSD and the Adreno graphics built into the Snapdragon X Elite chip. As is all too common, there's no way to upgrade the memory, but you can swap out

First look at other Copilot+ PCs

Both at Computex 2024 (*see p12*) and after, we've had the chance to get hands-on with a selection of Copilot+ PCs. Here are our favourites so far, with full reviews to follow soon.

Lenovo Yoga Slim 7x 14

PRICE £1,041 (£1,250 inc VAT) from lenovo.com

As its name suggests, Lenovo has doubled down on a slim design with its first Copilot+ PC. 12.9mm thin to be exact. It's finished in a striking Cosmic Blue colour, and despite that weight still includes a gorgeous 14.5in 2,944 x 1,840 OLED screen. All the models ship with the X1E-78-100 chip, as in the Vivobook, but you can spec it with up to 32GB of memory and a 1TB SSD for a very reasonable £1,400. Our one disappointment: that it only comes with three USB-C ports and a 3.5mm audio jack.

Microsoft Surface Pro, 11th Edition

PRICE From £874 (£1,049 inc VAT) from microsoft.com

Coming with a choice of Snapdragon X Plus or X Elite chips, Microsoft has ensured the Surface Pro is among the cheapest Copilot+ PCs at launch. Unless you want to buy it with a keyboard, that is, which will add at least £140 to the price. And the Slim Pen costs another £120. While the design remains largely unchanged from before, you now get the option of OLED panels with the more expensive X Elite designs, and there's something fantastic about having this much power (and quality) in such a tiny tablet.

Microsoft Surface Laptop, 7th Edition

PRICE From £874 (£1,049 inc VAT) from microsoft.com

As before, you can choose the Surface Laptop in either 13.8in or 15in incarnations, and Microsoft is selling both with a variety of specs and colours. We particularly like the plain black version, but only the boring Platinum option comes in at £1,049 – that's with the Snapdragon X Plus, 16GB of RAM and 256GB of storage. We should also mention that if you want the 15in edition, the price jumps to a £1,349 minimum, but with an X Elite. In our brief time with the 15in edition, though, we have to say that it's worth every penny in terms of build quality. Full review next month.

Samsung Galaxy Book4 Edge

PRICE From £1,166 (£1,399 inc VAT) from samsung.com

We review the basic Galaxy Book4 this month (*see p92*), and in terms of looks there isn't much difference with the Book4 Edge. So think slender stylings and a classy, understated, blue metal finish. You can buy it in 14in or 16in sizes, but unlike Microsoft with its Surface Laptop, you don't get a huge choice of specifications. Every model comes with 16GB of RAM and either a 512GB or 1TB drive, and if you choose the latter you'll upgrade the processor from the X1E-80-100 to the top-end X1E-84-100. We hope to review the Galaxy Book4 Edge next month.

the SSD for a new one if you're willing to battle past 13 Torx screws.

An Elite test

As well as being the debut for Microsoft's Copilot+ PCs, this is also the first time we've tested an Snapdragon X Elite processor. I've already mentioned that this Vivobook includes the bottom-most chip of the trio, the X1E-78-100, which means no dual-core boost and the default Adreno GPU.

The CPU is Qualcomm's Oryon, which features ten cores with a peak multithreaded frequency of 3.4GHz. Oryon is a departure for Qualcomm as it isn't licensed from ARM: this is its own custom design (technically it's still licensing the instruction set from ARM, but let's not get into the weeds). It's Qualcomm's attempt to fight toe-to-toe with Apple in terms of performance, which is one of the reasons why I include M2- and M3-based MacBooks in the graphs on p53.

What's obvious from the Geekbench 6 results is that, in terms of single-core speed, Apple holds the distinct edge. I've shown the results for the basic chips in Apple's range, to make it a fairer comparison with Qualcomm's most basic X Elite chip, but the M3 holds a huge advantage and Apple can feel smug that the M2 also beats it in Geekbench.

Switch to the multicore section, however, and the ten cores inside the X Elite's CPU make their presence felt. They even beat the 16-core Intel Core Ultra 7 155H (but bear in mind this is a mix of six P-cores, eight E-cores and two LE-cores). The exact scores don't matter: what does matter is that you aren't making any sacrifice in performance by buying a Copilot+ PC. In terms of multicore speed, it's quite the opposite.

Gaming woes

It's a different story when it comes to gaming. 3DMark tells some of the story, with the Vivobook sitting roughly level with the M2 MacBook Air (*see issue 336, p50*) and above the Zenbook 14 with its integrated Arc graphics. Solid results, to be sure. However, when I actually tried to play games on the Vivobook I was far from impressed.

Take *Shadow of the Tomb Raider*. Before this loaded, I was told it couldn't find a display driver; always a worry. The game still loaded up, but every time I tried to run the benchmark it crashed. So I moved on to *Dirt 5*, where everything worked, but frame rates were crushingly slow even at 1080p. At High ratings it averaged an unplayable 18fps, at Lowest an almost-but-not-quite-playable 28fps.

I'm sure that things will improve; this is an extremely early piece of hardware, and it went through three firmware updates during my week with it. I also expect that software and driver tweaks will push frame rates up. But for now, the message is simple: this is not a gaming platform.

All-day battery

One of Microsoft's most important claims for Copilot+ PCs is that they will deliver all-day battery life. And the early signs are that they will. The Vivobook S 15 includes a (replaceable) 70Wh battery, and while my tests didn't match Asus' stated 18+ hours of life, it did reach 14hrs 44mins when idling and 12hrs 49mins in the PCMark light-use Applications test. That was with the screen at 150cd/m² and Wi-Fi on, as with all our laptop battery testing.

"You aren't making any sacrifice in performance by buying a Copilot+ PC. In terms of multicore power, it's quite the opposite"

The main reason for Microsoft's confidence is the low power draw of the Qualcomm chipset, and this also translates into barely any fan noise. In fact, the only time many people may ever realise their Copilot+ laptop includes a fan (or two, as in this laptop's case) is during firmware

LEFT The keyboard is disappointing for a £1,300 laptop

updates, as these were accompanied by a maximum speed blast. The only other time I heard the fans kick into action was during games and prolonged benchmarks such as Cinebench R23 (it scored 12,850 in the multicore section, for the record).

I was also curious to see how well the Vivobook S performed on battery power, so I ran Geekbench 6 again. While its single-core result remained roughly the same, disappointingly it refused to go above 7,500 in the multicore section (I ran it several times). Some of this is due to Asus disabling the Performance fan mode when on battery, but I had hoped for more.

Asus ergonomics

That Performance fan mode is only available if you delve into the MyAsus app, and I strongly recommend anyone who buys this laptop (or any Asus laptop) to thoroughly explore this. It's particularly good for those who like to fine-tune the settings of their screens. Here, the app offers a choice of Native, DCI-P3, Display P3 and sRGB, but as this is a rich OLED screen it makes sense to choose a more impactful setting.

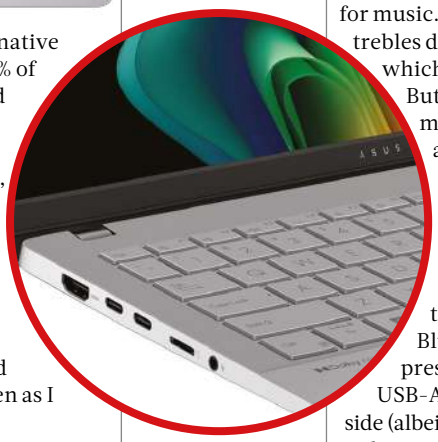
Or indeed keep it on the native setting, as this delivered 99% of the DCI-P3 colour space and 95% of Adobe RGB. All the usual adjectives for OLED panels apply – punchy, rich, vivid – and colour accuracy is superb. Add excellent whites, with a peak brightness of 381cd/m², and it's a great screen for work and entertainment.

For once, though, I found myself missing a touchscreen as I wanted to play around with Cocreator on the Vivobook. You can create basic shapes and scribbles using a mouse, but it's a far cry from being able to draw directly onto a screen. I've briefly played with this on Microsoft's new Surface Laptop, and it's a much more fluid experience.

I also found the Vivobook's keyboard action too squishy for my tastes; there's none of the crispness you get on Zenbooks, while the blue backlight lacks the white class of its sibling. And despite the generous 353mm width of the Vivobook S 15's chassis, Asus includes only a single-height Enter key and half-height cursor keys with doubled-up functions for Home, End, PgUp and PgDn. Some will take a literal positive from the number pad, but it's slimmed down.

The touchpad lacks the luxury glass coating of premium offerings, but what really matters is its generous 130 x 85mm size. Great for gestures and for navigating that 15.6in screen.

BELOW With Wi-Fi 7, Bluetooth 5.4 and a host of ports, this is a well-connected laptop



Final touches

Naturally, I also tried out the new webcam features. They're effective here, and the webcam along with the speakers are excellent, but my instinct is always to keep AI well away from webcams and microphones as they try to be too clever.

You don't get Asus' best speakers, but the two bottom-firing units here do a fine job in films and are listenable for music. Their main problem is that trebles dominate the bass and mids, which lends a harshness to tracks. But – at the risk of repeating myself – it's worth digging around the settings provided in MyAsus to tweak it to your liking.

One final note on connectivity: a nice bonus of Qualcomm's chipset is that it supports Wi-Fi 7 and Bluetooth 5.4, and both are present here. Add those to two USB-A ports on the right-hand side (albeit USB 3.2 Gen 1, so 5Gbits/sec) and two USB-C 4 ports on the left and this is a well-connected laptop. You also benefit from an HDMI 2.1 output, a microSD card slot and a 3.5mm jack.

"While the Vivobook S 15 includes a few downs to accompany its many ups, overall this is a strong debut for Copilot+ PCs"

So while the Vivobook S 15 includes a few downs to accompany its many ups, overall this is a strong debut for Copilot+ PCs. It's certainly whetted my appetite to test more, particularly those with faster versions of the X Elite chips. This particular laptop falls slightly short of a recommendation as I expect more refinement when paying £1,300 – particularly regarding the keyboard and design – but in terms of AI-power-per-pound, it sets a high bar for all those that will follow in its path. **TIM DANTON**

SPECIFICATIONS

10-core Qualcomm Snapdragon X1E-78-100 SoC • Qualcomm Adreno graphics • 16GB LPDDR5X-7467 RAM • 15.6in 120Hz OLED non-touch panel, 2,880 x 1,620 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • HDMI 2.1 • 2 x USB-C 4 • 2 x USB-A 3.2 Gen 1 • 3.5mm combo jack • microSD card reader • 70Wh battery • Windows 11 Home • 353 x 227 x 14.7-15.9mm (WDH) • 1.4kg • 1yr C&R warranty • part code, 90NB14Q2-M000M0

Comparison of Snapdragon X chips

Model name	Cores	Max multithread frequency	Dual-core boost	Adreno GPU TFLOPS	NPU TOPS
Snapdragon X Elite X1E-84-100	12	3.8GHz	4.2GHz	4.6	45
Snapdragon X Elite X1E-80-100	12	3.4GHz	4GHz	3.8	45
Snapdragon X Elite X1E-78-100	12	3.4GHz	✗	3.8	45
Snapdragon X Plus X1P-64-100	10	3.4GHz	✗	3.8	45

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SCAN

Asus Zenbook 14 OLED (UX3405)

Despite the aggressive price, this premium laptop has power, battery life and style to spare

SCORE ★★★★★

PRICE Core 7 Ultra, £1,083 (£1,299 inc VAT) from uk.store.asus.com

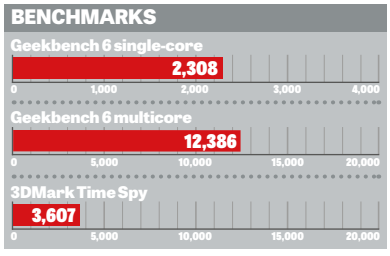
PC PRO RECOMMENDED

When it comes to laptops, the truism "you get what you pay for" still holds true. There are great machines in our group test of sub-£1,000 laptops (*see p78*), but by breaking into four figures you step up in almost every key area: speed, design and build quality.

I tested the Core 7 Ultra version of the latest Zenbook 14, but prices start at £1,100 for the Core Ultra 5 machine. That won't finish core-hungry tasks as quickly – it has four P-cores rather than six and is clocked slightly lower – but it won't be far off. For example, where the 155H pushed this laptop to 12,386 in Geekbench 6's multicore test, I'd expect the 125H-powered system to return around 11,500. Despite Intel's latest integrated graphics, however, neither are gaming superstars: to hit 50fps in *Shadow of the Tomb Raider* I reduced quality settings to Lowest and the resolution down to 1,920 x 1,080.

Both systems include 16GB of embedded RAM, but removing the base reveals a replaceable, super-slim M.2 2280 SSD. You get a 1TB SSD here compared to 512GB in that base model, and it's pretty fast: 5,002MB/sec reads, 3,518MB/sec writes.

BENCHMARKS



BATTERY LIFE

What dominates your view when you remove the base, however, is the replaceable 75Wh battery. This should last a working day: it kept the Zenbook going for 12hrs 21mins in PCMark's Modern Office test and 15hrs 54mins when left idling. Great scores for a 1.3kg laptop with a 14in 120Hz OLED touchscreen.

That screen is one of this laptop's finest features, and coupled with Asus' advanced controls – available via its MyAsus app – you can switch between sRGB, DCI-P3, Display P3 and native colour profiles with ease. And it will hop between them accurately: sRGB covers 98% of that space, DCI-P3 99.5%. And colour accuracy is superb, with a typical average Delta E of 0.5.

I'm not in love with the keyboard, despite a crisp feel to the keys. That's because it's slightly off centre: the mid-point is around 10mm further to the right than usual, presumably to free up space; it allows Asus to separate out the cursor keys, for example. I also prefer a double-height Enter key, but otherwise the keys are big and easy to hit. It's reasonably quiet, too, and three backlight levels are always useful.

There's no number pad, until you press the icon at the top right corner of the glass-coated touchpad. The idea is that you can tap away as if they were actual keys. To me, it's a gimmick, but I do love the pad's wide aspect ratio for Windows gestures.

Asus could have been more generous with its port selection. A single USB-A port sits on the left, while the right side offers an HDMI 2.1 connector and two USB-C 4/Thunderbolt 4 ports. So what you lack in numbers you make up for in bandwidth and versatility. One of these USB-C ports is required for power input, with Asus providing a traditional rat-and-tail power supply that weighs 320g and occupies annoying space in a bag.

ABOVE The 14in OLED touchscreen is one of this laptop's highlights

"You can expect crisp visuals, great noise capture and enjoyable music playback. The speakers go loud, too"

I've noticed that all laptop manufacturers have stepped up their game when it comes to webcam, mics and speakers in the past year, and the Zenbook 14 is no exception. You can expect crisp visuals, great noise reduction (but play around in the MyAsus settings to avoid AI trying to be too clever) and enjoyable music playback. The speakers go loud, too, which could come in handy if this becomes your travel laptop.

LEFT The attractive design is a key part of the Zenbook's appeal

You can also expect stolen glances at your laptop from fellow travellers, as it's an attractive thing. Asus adds its usual geometric patterns to the lids, but it's the matte blue aluminium finish coupled with its sleek dimensions that catch the eye.

I would expect it to look good for several years to come, too, but you might still be well advised to extend the warranty beyond the single year of cover it comes with. Fortunately, there's an easy way to make budget for that: if you're happy with a 512GB SSD, you can instantly save £200 without sacrificing any of this laptop's key attractions. **TIM DANTON**

BELOW A number pad appears on the touchpad when you click the icon

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • Intel integrated Arc graphics • 16GB LPDDR5X-7467 RAM • 14in 120Hz OLED touchscreen, 2,880 x 1,800 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p IR webcam • HDMI 2.1 • 2 x Thunderbolt 4/USB-C 4 • USB-A 3.2 Gen 1 • 3.5mm combo jack • 75Wh battery • Windows 11 Home • 312 x 220 x 14.9mm (WDH) • 1.3kg • 1yr C&R warranty • part code, UX3405MA-PZ185W

HP Spectre x360 16 (2024)

This sleek 2kg convertible packs everything you need, including a Core Ultra chip and optional Nvidia graphics

PC PRO RECOMMENDED

SCORE ★★★★★

PRICE As reviewed, £1,716 (£2,059 inc VAT) from hp.com/uk

If you're looking for a big, flexible laptop, the HP Spectre x360 16 will make you very happy indeed. Its 16in screen delivers bags of desktop space; there's ample power for apps and games; the convertible design provides plenty of usage options; and the included stylus makes it a great tool for artists and graphic designers.

The entry-level model costs £1,799 inc VAT and comes with an Intel Core i7-1360P CPU, 16GB of RAM, a 1TB SSD and a gorgeous 4K OLED touchscreen; the model I tested has a newer Core Ultra 7 155H CPU, GeForce RTX 4050 graphics and a 120Hz screen, but the resolution drops to 2,880 x 1,800.

HP hasn't changed the design of the Spectre x360 16 in a few years, but the slate blue colour still looks characterful yet professional. The hinge is remarkably sturdy, so you can tilt the screen any way you want and it will stay in place without any sagging or wobbling.

HP neatly hides a couple of ports into the gem-cut back corners: the right offers a USB-C port, which is perfectly placed for charging, while a headphone jack sits at the left. On the sides you'll find another USB-C port, one USB-A port and an HDMI 2.1 socket. That's enough for most setups.

LEFT A sturdy hinge lets you tilt the screen at any angle you want

The spacious OLED panel is like a mini-cinema: I was delighted by how the Spectre x360 brought the world of *Camp Half-Blood* to life. And while a peak brightness of 376cd/m² sounds dim, the perfect contrast of OLED makes images look bold and bright. Colour is vibrant, too, with 87% coverage of the DCI-P3 space.

The Spectre x360 also does a great job on the audio front thanks to two front-facing units speakers built into the front edge. This makes a world of difference for both music and films: things can get seriously loud, with crisp vocals and bold, satisfying bass.

The keyboard provides a satisfying typing experience, offering tactile feedback without being loud or clicky, and the touchpad is one of the roomiest I've used. It feels positively luxurious, but I did occasionally find myself accidentally moving the cursor when typing, so palm rejection needs a little fine tuning.

In terms of performance, the Spectre x360 16 is equal to virtually anything you throw at it. I found it handled everyday productivity and content-creation tasks with ease: web pages and apps loaded quickly and ran smoothly, while Adobe Lightroom and Fresco purred along without a hiccup. An impressive score of 12,592 in the Geekbench 6 multicore test puts the HP ahead of even the MacBook Air M3 for CPU compute power. The model I tried also made a strong fist of gaming, with 41fps in *Civilization VI: Gathering Storm* at the panel's native resolution.

ABOVE The 16in OLED screen makes images look bold and bright

I also enjoyed using the Spectre in tablet mode. The bundled pen works well, and you can swap out the tip with two differently-sized extras included in the box. The 360° hinge lets you swivel the screen around, prop it up on the base and draw on it like an easel.

"The large OLED display is a joy to behold, while the speakers are among the best I've ever heard on a laptop"

Battery life is another strength, with the Spectre lasting 11hrs 7mins in our tests, and for the most part it ran cool: the underside vents hit an uncomfortable peak of 37°C only during a demanding session of *Starfield*.

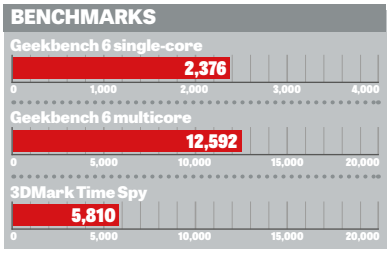
Overall, this is a powerful 2-in-1 that justifies its price with a stylish, versatile design, excellent performance and all-day battery life. The large OLED display is a joy to behold, while the speakers are among the best I've ever heard on a laptop, making this an excellent choice for media creation and consumption. **STEVIE BONIFIELD**

BELOW A USB-C port and headphone jack are built into the cut corners at the rear

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • 6GB Nvidia GeForce RTX 4050 graphics • 16GB LPDDR5X-6400 RAM • 16in 120Hz OLED touchscreen, 2,880 x 1,800 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 9MP IR webcam • HDMI 2.1 • 2 x Thunderbolt 4/USB-C 4 • USB-A 3.2 Gen 2 • 3.5mm combo jack • 83Wh battery • HP Tilt Pen • Windows 11 Home • 357 x 245 x 19.8mm (WDH) • 2kg • 1yr RTB warranty • part code, 9D1Q4EA#ABU

BENCHMARKS



BATTERY LIFE

Razer Blade 16 (2024)

Still one of the sleekest and most beautiful gaming laptops around, but now with more effective cooling

SCORE ★★★★★

PRICE RTX 4090/32GB RAM/2TB SSD, £3,500 (£4,200 inc VAT) from razer.com

The Razer Blade 16 has been one of our favourite gaming laptops for years, and with its big screen, high-end CPU and Nvidia RTX graphics it makes a stonking graphical workstation, too.

What it's never been is a machine for people with light wallets. The new entry-level model for 2024 comes with a 24-core Intel Core i9-14900HX processor, an Nvidia RTX 4070 GPU, a 1TB SSD and 16GB of RAM – and it costs £3,000 inc VAT. The model I tested was upgraded with an Nvidia RTX 4090 GPU, plus double the storage and memory, bringing the price up to £4,200 inc VAT. If you want 4TB of storage and 64GB of RAM, you'll have to pay an enormous £4,600 inc VAT.

LEFT The iconic black and green case looks as good as ever

Same looks, desktop power

The new Blade 16 looks almost identical to previous models, with a minimalist black and green aluminium chassis. No laptop with a 16in screen could ever be called compact, but with a footprint of 355 x 244mm and a weight of 2.5kg it's fine to throw in a rucksack. If you prefer a different balance, Razer offers Blade models with screen sizes ranging from 14in to an imposing 18in.

As you'd hope, the Razer Blade 16 makes a fine desktop replacement, with all the connectivity you're likely to need. That includes a Thunderbolt 4 port with 100 watts of power delivery, four 10Gbits/sec USB ports (one Type-C and three Type-A), HDMI 2.1, a 3.5mm combo audio jack and a UHS-II SD card reader slot. Whether you're gaming, editing video or 3D modelling, you're unlikely to need a hub.

My only gripe is with the integrated webcam: it has a 1080p resolution with infrared sensing, so it works fine for Windows Hello, but it made my face look grainy in video calls, and colouring was inconsistent across different videoconferencing applications. For the price I'd hoped for something closer to professional streaming standards.

Striking screen

The most striking thing about the Razer Blade 16 is its screen. The 16in OLED panel is gorgeous, with crisp contrast and vivid colour. It offers a bigger-than-4K native resolution of 3,840 x 2,400, with an ultra-smooth 240Hz refresh rate. In partnership with the Nvidia RTX GPU, games, videos and professional apps look incredibly sharp and slick.

ABOVE The Razer Blade 16 is a fantastic choice for gamers with deep pockets

PC PRO A-LIST

"The most striking thing about the Blade 16 is its screen. The 16in OLED panel is gorgeous, with crisp contrast and vivid colour"

The screen doesn't have the widest colour gamut we've seen. We measured 78% coverage of the DCI-P3 colour space, which might be a concern for videographers. Then again, its Delta-E accuracy of 0.21 is as near to perfect as makes no odds.

On paper the OLED screen isn't that bright, either – we measured an average luminance of 378cd/m² at maximum brightness. However, the perfect blacks provided by OLED make everything look bolder and richer than the numbers might suggest. If you want more brightness, Razer offers another screen with an interesting dual-mode mini-LED, which supports the full resolution at 120Hz or 1,920 x 1,200 at 240Hz. On that model, I measured a peak brightness of 509cd/m²; while you miss out on the perfect contrast of the OLED model, the mini-LED technology still looks spectacular.

Great to use

Using the Razer Blade 16 is a pleasant experience. The comfortable, springy keyboard has excellent click actuation, which is not only enjoyable to use but very productive: the 10FastFingers app reported that I was actually typing a little faster than my usual speed. There's also per-key RGB lighting, controllable via Razer Synapse.

The large touchpad, meanwhile, is lovely and smooth, although it took me a while to adjust to the left- and right-click zones. Don't be concerned that the touchpad covers much of the palm-rest area: palm rejection worked very well, with no accidental clicks or mouse movements while I was typing.

For audio, the Razer Blade 16's four-speaker array proved powerful enough to provide high-quality sound throughout a large meeting room. At moderate volumes it fully conceals any fan noise, although once you push towards maximum volume things start to sound tinny and distorted.

The big question: speed

So much for the build quality; the big question is, how does it perform? Since the Blade 16 is overtly positioned as a gaming laptop, I started out by trying some demanding games – and I wasn't disappointed.

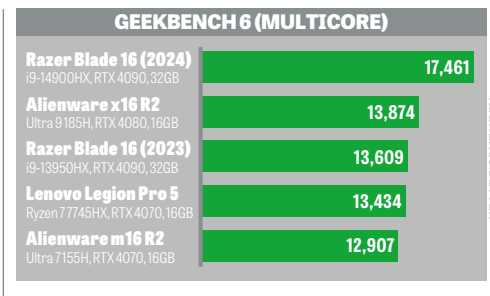
In *Baldur's Gate III*, I was stunned by the amount of detail in the character models and clothing that the RTX 4090 GPU was able to animate in real-time. It was a similar story with my personal gaming addictions, *Genshin Impact* and *Final Fantasy XIV: Endwalker*, which both easily maintained a consistent 60fps on the highest graphic settings. As an experiment I tried replacing my gaming desktop with the Blade 16 for a week, and – outside of the form-factor – I honestly noticed no difference in my gaming life. As you'll see from our graphs above, it's an impressive performer across the board.

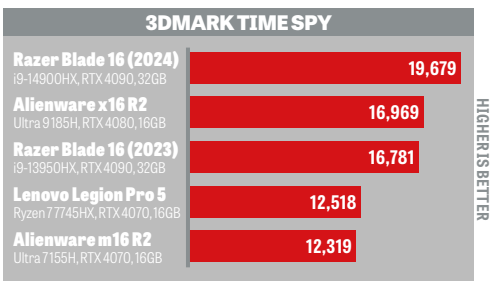
That carries over to desktop apps, too. Whether I was working in Photoshop or juggling a nearly unconscionable amount of Chrome tabs, the Blade 16 kept up with my needs without the slightest lag or stutter. In the Geekbench 6 multiplatform CPU benchmark it returned a superb multicore score of 17,461. The latter puts it far ahead of gaming laptops that use a Core Ultra 7 155H processor – such as the Alienware m16 R2, which scored 12,784 – or the Lenovo Legion 5 Pro 2023, with its AMD Ryzen 7 7745HX delivering a multicore result of 12,414.

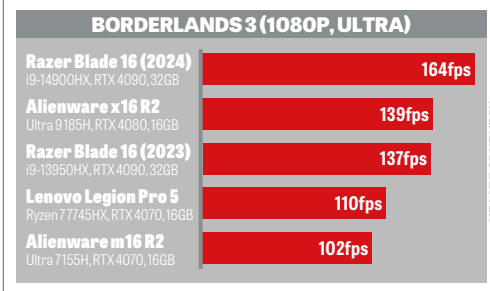
The Blade 16 also raced through our video-encoding benchmark, taking only 2mins 48secs to convert our sample clip from 4K to Full HD. That's almost a minute faster than gaming laptop rivals such as the Alienware m16 and the Legion 5 Pro.

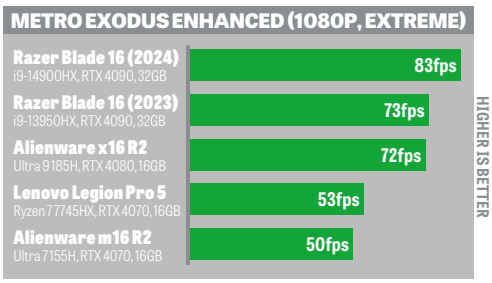
LEFT The selection of ports makes the Blade 16 an ideal desktop replacement

ABOVE The excellent keyboard may even boost your typing speeds









Heat and battery life

At this point it's worth talking about heat and fan noise. Keeping both under control is always a challenge for gaming laptops: cramming a ton of performance and power into a portable chassis inevitably ramps up the temperature, and while Razer talks a lot about its custom vapour-chamber cooling system, the Blade 16 will still get hot while gaming. And that means the fans create a furore to match.

After five runs of the *Metro Exodus* Enhanced Edition benchmark (at Extreme settings) I measured a peak of 48°C on the rear underside just near the riser – well above our comfort threshold. I also noticed that the laptop gradually warmed up while playing *Baldur's Gate III*; the first hour or so was fine, but after that I switched to an external keyboard for comfort.

The other usual compromise with gaming laptops is battery life. With a top-end Core i9-14900HX CPU and that RTX 4090 GPU on board, the Blade 16 devours power even more quickly than rival laptops; in our standard battery test at a screen brightness of 150cd/m², it only lasted 4hrs 41mins away from the mains, while the Alienware m16 R2 eked out 6hrs 13mins from a full charge. You should be just about okay to take this laptop out and about for an afternoon, but for the most part you'll want to keep it near to a power socket.

Final word

No doubt about it, the Razer Blade 16 is a beast of a laptop. The version I tested achieved exceptional performance figures, but even the base model – which, as a reminder, has the same processor but drops the RAM to 16GB and the graphics card to Nvidia's RTX 4070 – should keep up with any modern game or professional workload.

And both the RAM and the SSD are upgradeable, with an extra SSD slot that supports up to 2TB drives.

The laptop certainly has weaknesses: it's expensive, it gets hot and noisy when pushed, and it doesn't last long away from the mains. While you can level the same criticism at any gaming laptop to some extent, the Blade 16's battery life – on the model I tested at least – is shorter than most.

However, if you can live with that, and have the budget to spare, the 2024 Razer Blade 16 is a superb laptop. It offers a sumptuous screen, bags of connectivity and performance above the competition. If you're in the market for a powerful 16in laptop that will eat up games and creative applications, this is the one to go for.

MADELINE RICCHIUTO

SPECIFICATIONS

24-core (8 P-cores, 16 E-cores) Intel Core i9-14900HX processor • 16GB Nvidia GeForce RTX 4090 graphics (up to 140W) • 32GB DDR5-5600 RAM • 16in non-touch, OLED display, 240Hz, 2,560 x 1,600 resolution • 4TB M.2 Gen4 SSD • Wi-Fi 7 • Bluetooth 5.3 • 1080p webcam • Thunderbolt 4 • USB-C 3.2 Gen 2 • 3 x USB-A 3.2 Gen 2 • HDMI 2.1 • UHS-II SD card reader • 3.5mm combo jack • 95Wh battery • Windows 11 Home • 355 x 244 x 22mm (WDH) • 2.5kg • 1yr limited warranty • part code: RZ09-05102WN4-R3W1

Geekom A8 Mini PC

This compact powerhouse over-delivers in almost every area, but the Ryzen 7 version is better value

SCORE ★★★★★

PRICE Ryzen 9, £749 (£899 inc VAT) from geekom.co.uk

There has been a growing demand from *PC Pro* readers – via social media and emails – for us to review more compact PCs, so when Geekom offered its new A8 Mini PC for review I quickly accepted. Especially when I saw the specification: for £719 inc VAT you can buy a Ryzen 7 8845HS with 16GB of RAM and a 1TB SSD; the £899 system I tested doubles the storage to 2TB and packs a Ryzen 9 8945HS.

Both of these eight-core, 16-thread CPUs are designed for laptops, but the "HS" in their name denotes their high-performance status. The Ryzen 9 clocks higher, with a 5.2GHz peak to 5.1GHz (and a base frequency of 4GHz versus 3.8GHz), but aside from this the only difference is that the Radeon 780M graphics chip boosts to 2.8GHz versus 2.7GHz. For such marginal gains, I would save £180 and buy the Ryzen 7 edition.

The other good news is that both chips feature AMD's latest Zen 4 architecture, and include AMD Ryzen AI (albeit with a modest 16 TOPS rating) to aid any software that takes advantage. Such software is slowly emerging, so don't dismiss Ryzen AI as a gimmick. This chip also provides decent performance in games, returning 3,215 in 3DMark Time Spy – roughly the same as Intel's best integrated graphics – and a solid 35fps in *Shadow of the Tomb Raider* at 1080p High settings.

This mini PC proved to be a storming performer in all our other benchmarks. Single-core results of 2,561 in Geekbench 6 and 1,819 in Cinebench R23 indicate the power of AMD's Zen 4, while multicore returns of 13,236 and 16,615 respectively are excellent. Despite the tiny confines of the A8 Mini PC – the fans only whirr into quiet-if-whiny action when thoroughly pushed – it can handle demanding tasks with ease.

Overall, it's notably faster than the £699 Geekom Mini IT 13 (*see issue 350, p46*), despite that including a 14-core Intel i9-13900H. We benchmarked the Mini IT 13 in Geekbench 6, and while the A8 was only 116 points ahead in Geekbench's single-core section (the Mini IT 13 scored 2,445), the Intel-powered system was almost 2,000 behind in the multicore test and could only rustle up 1,922 in 3DMark Time Spy.

Or compare the A8 to the HP All-in-One 27 opposite, which uses a less powerful 13th-generation Intel Core i7-1355U processor. There isn't a single benchmark where it comes close to the Geekom, and that's noteworthy because the A8 ships with a mounting plate so you can attach it to the rear of a monitor. Indeed, the Philips 276B1JH (*see issue 358, p70*) I reviewed last month includes a power output and cable that plugs into the A8's barrel power connector. And the A8 only requires 101W at most.

Geekom packs in the connectors, too, with a pair of USB-A 3.2 Gen 2 ports on the front (plus headphone jack and power button) that support 10Gbits/sec transfers. A full-size SD card sits on its side, while the crowded rear includes two more USB-A ports (one USB 3.2 Gen 2, one USB 2) plus two USB-C ports. You can spot the USB 4 port as it says 40, to ref lect that standard's 40Gbit/sec transfer speeds, while the other is USB 3.2 Gen 2. Add two HDMI 2 ports and a 2.5GbE connector, not to mention Wi-Fi 6E, and you have one superbly equipped machine.

The 32GB of DDR5 memory comes supplied as two SODIMMs, both of which can be replaced – as can the scorchingly fast 2TB SSD, with 7,094MB/sec reads and 6,327MB/sec writes. However, the Wi-Fi antenna is delicately soldered onto the motherboard, and by removing the base I unavoidably detached this. So proceed with caution, and ideally a soldering iron on hand to remake the connection.

"Compared to previous mini PCs I've tested, the amount of power the Geekom A8 packs in per square millimetre is leagues ahead"

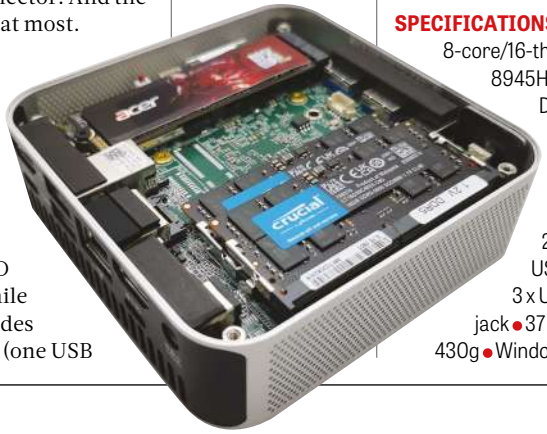
The M.2 Wi-Fi card is the only other component end users can replace, which isn't surprising when you consider the size of this computer. To put its 112 x 112mm footprint into perspective, a typical drinks coaster is around 100mm x 100mm.

Compared to previous Mini PCs I've tested, the amount of power the Geekom A8 packs in per square millimetre is leagues ahead. The fact it does so in such a compact unit – 12mm shorter than the Mini IT 13 – and is finished in a stylish, brushed metal, only adds to its attractions. Over the coming months I'll be testing more mini PCs, including Asus' NUC 14 Pro, but I expect the Geekom A8 Mini PC to more than hold its own. **TIM DANTON**

ABOVE The A8 Mini PC packs a powerful punch in a tiny package

LEFT The rear of the PC has all the ports you could wish for

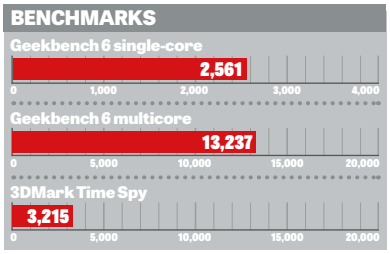
BELOW The memory and speedy SSD can be easily replaced



SPECIFICATIONS

8-core/16-thread AMD Ryzen 9 8945HS processor • 32GB DDR5-5600 RAM • AMD Radeon 780M graphics • 2TB M.2 NVMe Gen 4 SSD • SD card reader • Wi-Fi 6E • Bluetooth 5.2 • 2.5GbE port • 2 x HDMI 2 • USB-C 4 • USB-C 3.2 Gen 2 • 3 x USB-A 2 • USB-A 2 • 3.5mm jack • 37 x 112 x 112mm (WDH) • 430g • Windows 11 Home • 3yr warranty

BENCHMARKS



HP All-in-One 27 cr-0014na PC

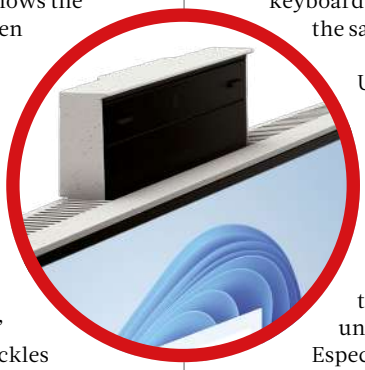
A speedy and temptingly priced all-in-one PC with a fine 27in display – but note its 1080p resolution

SCORE ★★★★☆

PRICE £666 (£799 inc VAT)
from hp.com/uk

The first sign of any product's quality comes when you unpack it from its box, especially when it's honed to hit a budget. Does it feel too light, look too plasticky? Have corners been cut that make it horrible to use? In short, does it feel cheap?

So it was with an inward sigh of relief that I started assembling the HP All-in-One 27. Finished in all white, it looks classy, while the stand not only includes 100mm of height adjustment but a felt-covered base. That may sound trivial, but it shows the attention to detail often lacking in budget laptops and PCs.



HP has also taken account of this machine's environmental impact, using 40% post-consumer recycled plastic, 10% recycled metal and even using "recycled" coffee grounds as speckles in the plastic. Sadly, that isn't reflected in any kind of smell.

Another nice touch is the 1080p camera built into the top bezel. You slide this up when needed – I kept it up as it's great for face recognition – and down if you're worried about privacy. It isn't the world's finest webcam, capturing a grainy image with such a wide angle that I had to lean in close to fill the frame, but at least the mic works well.

A basic wireless keyboard and mouse set come in the box. The keyboard's plastic keys have the same cushioning as a park bench, and it's so light that it will be pushed out of position by an extra vigorous keypress. But it includes useful function keys, particularly the brightness up/down for the screen: I looked in vain for other physical controls for the display, or software control in the various HP utilities. The mouse is a simple two-button affair, unless you count the clickable scroll wheel, and both it and the keyboard connect to the PC via the same USB dongle.

This leaves three USB-A ports free, with a solitary USB-C port keeping it company. Aside from one USB-A 2 port, all these are limited to USB 3.2 Gen 1's 5Gbits/sec transfers, which is unnecessarily mean. Especially when the supplied SSD offers only 512GB of storage. While you can theoretically get inside this device to replace the drive, as well as the 16GB of RAM (supplied via two 8GB DDR4 SODIMMs), you'll need time, patience and skill.

HP sticks to Wi-Fi 6 rather than 6E, but it's always nice to see a physical Ethernet port (gigabit, not 2.5GbE), and there's a bonus in the form of an HDMI 1.2 output. This spec is getting on for 20 years old, which is reflected in the fact that the highest-resolution screen you can connect at 60Hz is 1,920 x 1,080. Still, if you have a 1080p screen knocking around it could be useful.

I could be critical of the HP's 27in panel, as it's a non-touch 1080p unit with a pixel density of 82ppi. Not great, but at typical viewing distances I was never irritated by a lack of sharpness. It helps that colours are a strong point: it covers 95% of the sRGB space with good accuracy – its average Delta E is 0.68 – while a peak brightness of 275cd/m² is fine for use indoors.

The HP All-in-One is a surprisingly strong choice for films, too, with a pair of beefy 2W speakers that handle explosive scenes and music equally well. Not to the point of audiophilic delight, perhaps, but enough that you can listen to Spotify while working. Their only weakness is lack of volume, but there's enough oomph to fill a study.

Some might criticise this PC's power, too, as it includes a relatively timid Core i7-1355U. That's now been usurped by Intel's Core 7 processor 150U, but this would only give you a minor speed bump; they share the same basic design of two P-cores and eight E-cores, but the 150U's peak frequency is higher (5.4GHz vs 5GHz). Besides, this machine is extremely nippy; you'll only wish you had a more powerful CPU, such as the Ryzen 9 in the Geekom A8 opposite, is if you max out the cores when coding or editing.

HP relies on the Iris Xe graphics built into the processor, and that means any modern game is out of bounds. To make *Shadow of the Tomb Raider* playable I dropped to 720p resolution and Lowest settings for an average of 37fps; at 1080p, it was a shaky 23fps.

But this machine isn't designed for games, and despite its year-old processor and elephant's graveyard of old standards – HDMI 1.2, really? – I ended up enjoying my time with the HP All-in-One 27. Would I have liked it more if the screen was 1440p, the keyboard less Lego-like and there was a shade more power inside? Yes, undoubtedly. At this price, however, I'm willing to overlook such flaws. It offers quality where it counts – the design, the build quality, the screen, the speakers – and £799 is extremely competitive. **TIM DANTON**

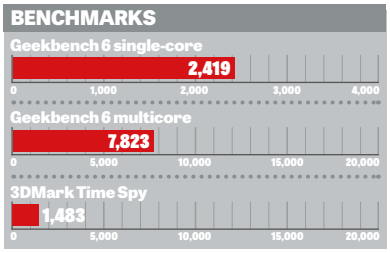
ABOVE HP's All-in-One 27 is a well-built PC for the price

"Colours are a strong point: it covers 95% of the sRGB space with good accuracy and its average Delta E is 0.68"

LEFT The 1080p camera built into the top bezel is a nice touch

BELOW The stand includes 100mm of height adjustment

BENCHMARKS



SPECIFICATIONS

10-core (2 P-cores, 8 E-cores) Intel Core i5-1355U processor • Intel Iris Xe graphics • 16GB DDR4-3200 RAM • 27in 60Hz IPS non-touch panel, 1,920 x 1,080 resolution • 512GB M.2 PCI-E Gen4 SSD • Wi-Fi 6 • Bluetooth 5.3 • gigabit Ethernet • 1080p IR webcam • HDMI 1.2 output • USB-C 3.2 Gen 1 • 2 x USB-A 3.2 Gen 1 • USB-A 2 • 3.5mm combo jack • 2 x 2W speakers • HP 510SP wireless keyboard and mouse • Windows 11 Home • 613 x 186 x 517mm (WDH) • 6.7kg • 1yr limited RTB warranty

Lenovo Tab P12 with Matte Display

If you and your eyes are tired of glossy screens, this compact 12in Android tablet might just be the answer

SCORE ★★★★☆

PRICE £375 (£450 inc VAT)
from lenovo.com/uk

Allow me to be frank. If this tablet came with a standard glossy display, it would be consigned to the already overflowing *PC Pro* bin of me-too Android tablets. The processor is so middle-of-the-road it attends Billy Joel concerts in a home-knit jumper; the design so bland that it makes tapioca pudding look like a knickerbocker glory. Yet I grew to love it, for one reason only: its paper-like screen.

For, despite this tablet's prosaic name, this isn't a matte display in the usual sense; when we describe a matte display on a laptop, we essentially mean that it isn't glossy. Here, it's truly akin to paper, able to soak up light in a similar way to an E Ink screen. However, if you're thinking drab colours and poor response times, let me reassure you: switch to Vivid mode and the panel covers 92% of the DCI-P3 gamut with excellent accuracy, and that means you'll enjoy photos and films as you'd expect. Lenovo doesn't quote response times, but it's fine for streaming sport and playing games, aided by a 2,944 x 1,840 resolution.

It's worth digging around in the display settings, too, with the Reading Mode tweaking colours and contrast to make it even easier to read for long periods. I have only one word of warning, and that's for those who might want to use this tablet in sunny conditions. When I rushed out to view the screen under a rare flash of British summer sun, I struggled to make out the screen's contents.

I also have bad news for anyone hoping for a paper-like writing experience, as the stylus feels exactly the same against the screen as any other tablet. In fact, the Lenovo Tab Plen Plus' only notable feature is that it attaches securely (via magnets) to the rear of the tablet, but you'll need to charge it via the USB-C slot. And note that the cheapest model on Lenovo's website doesn't come with an adapter or folio case, so choose carefully from the options when buying. I would be most tempted by the version with a clip-on keyboard (three POGO pins sit at this tablet's base), despite its £580 price. All the models feature 128GB of storage, with a microSD card slot available for adding more.

You'll find two speakers on either side, which are at their best in films thanks to their support for Dolby Atmos effects. They're good enough to listen to music on, but didn't have the bass or detail to bring tracks to life.

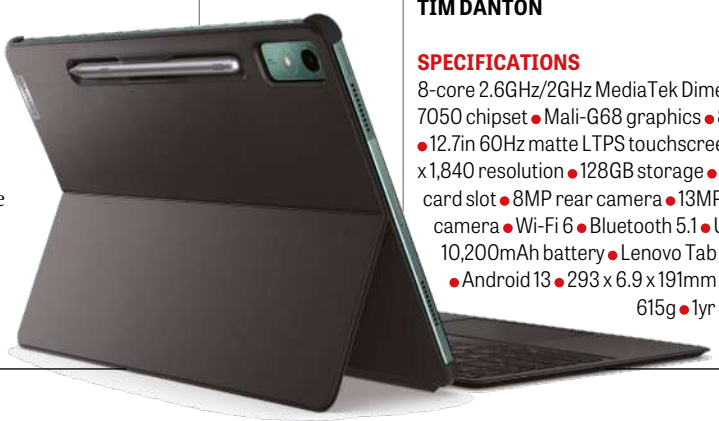
Then we come to the processor, a MediaTek Dimensity 7050 with two 2.6GHz Cortex-A78 cores and six 2GHz Cortex-A55 cores. With 8GB of RAM, it's fine for Android 13 and all the everyday tasks most people will use this tablet for, although its weakness shows when loading up complicated web pages or playing games. For instance, its 3DMark Wild Life Original score of 2,114 translates into 13fps. Battery life is another weak point, lasting for a shade over six hours in our 1080p video-rundown test.

ABOVE An unusual matte display sets the Lenovo Tab P12 apart

"This isn't a matte display in the usual sense. Here, it's truly akin to paper, able to soak up light in a similar way to an E Ink screen"

LEFT Rounded corners soften the tablet's appearance

BELOW The Tab Plus stylus attaches magnetically to the rear of the tablet



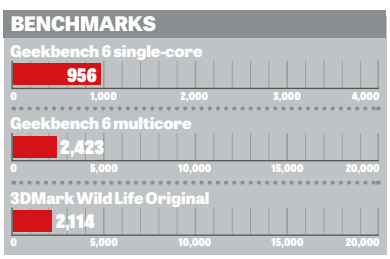
While I was critical of the P12's design, there's nothing truly wrong with it. Rounded corners soften its looks, and Lenovo picks an attractive sage green finish for the metal case. At 6.9mm it looks plump next to the latest iPads, but I can't argue about a weight of 615g – except to say that Lenovo should have made it heavier and squeezed in an even bigger battery.

But then we come to the price: when paying under £500 you can't expect the world. However, it faces tough competition, particularly in the form of the OnePlus Pad (*see issue 346, p46*), which originally cost £449 and can now be bought for £329. And that is much faster, has better battery life and only loses out for the size of its screen: 11.6in rather than 12.7in. Plus, of course, it's glossy.

This essentially means that the Lenovo Tab P12 with Matte Display is a one-trick pony. It's a trick that I happen to admire, but I would wait for the Tab's price to come down – which Lenovo may be forced to do when more paper-like tablets go on sale.

TIM DANTON

BENCHMARKS



SPECIFICATIONS

8-core 2.6GHz/2GHz MediaTek Dimensity 7050 chipset • Mali-G68 graphics • 8GB RAM • 12.7in 60Hz matte LTPS touchscreen, 2,944 x 1,840 resolution • 128GB storage • microSD card slot • 8MP rear camera • 13MP front camera • Wi-Fi 6 • Bluetooth 5.1 • USB-C 2 • 10,200mAh battery • Lenovo Tab Pen Plus • Android 13 • 293 x 6.9 x 191mm (WDH) • 615g • 1yr warranty

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pro-series

mid [PRO1]

£449.99

CPU	AMD RYZEN 5 8500G
Core	6 Cores - 12 Threads
Clock	(3.5/5Ghz Turbo)
Mob	ASUS TUF A620M-PLUS WIFI
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	AMD RADEON Graphics
Case	KOLINK Observatory HF MESH
O/S	*NO OPERATING SYSTEM*
PSU	BUILDER 500W PSU

Max [PRO2]

£979.99

CPU	AMD RYZEN 5 7600X
Core	6 Cores - 12 Threads
Clock	(4.7/5.3Ghz Turbo)
Mob	ASUS PRIME B650M-A WIFI II
RAM	ADATA 32GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	1stPlayer D3-A aRGB - Black
O/S	*NO OPERATING SYSTEM*
PSU	CIT 700W PSU

UBER [PRO3]

£1159.99

CPU	INTEL Core i5 14600K
Core	14 Cores - 20 Threads
Clock	(2.6/5.3Ghz Turbo)
Mob	ASROCK B760M-H/M.2
RAM	ADATA 32GB DDR5 5600Mhz
M.2	ADATA 2TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	GAMEMAX F15M MESH
O/S	*NO OPERATING SYSTEM*
PSU	BEQUIET 850W Gold PSU

Aurora RANGE

i3 Aurora [AUR1]

£629.99

CPU	INTEL Core i3 14100F
Core	4 Cores - 8 Threads
Clock	(3.5/4.7GHz)
Mob	ASROCK B760M-H/M.2 DDR5
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX3050 8GB
Case	GAMEMAX Abyss Mini RGB
O/S	MICROSOFT Windows 10/11
PSU	CIT 600W Bronze PSU

i5 Aurora [AUR2]

£999.99

CPU	INTEL i5 14400F
Core	10 Cores - 16 Threads
Clock	(Turbo 4.7Ghz)
Mob	ASROCK B760M-H/M.2 DDR5
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 2TB M.2 NVMe
GPU	NVIDIA RTX4060 8GB
Case	CORSAIR iCUE 4000X
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W PSU

i7 Aurora [AUR3]

£1599.99

CPU	INTEL Core i7 14700KF
Core	20 Cores - 28 Threads
Clock	(3.4/5.6Ghz Turbo)
Mob	ASUS PRIME Z790-P WIFI - DDR5
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 1TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4070 12GB
Case	CORSAIR iCUE 4000X RGB
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W Gold PSU

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Your bonus software

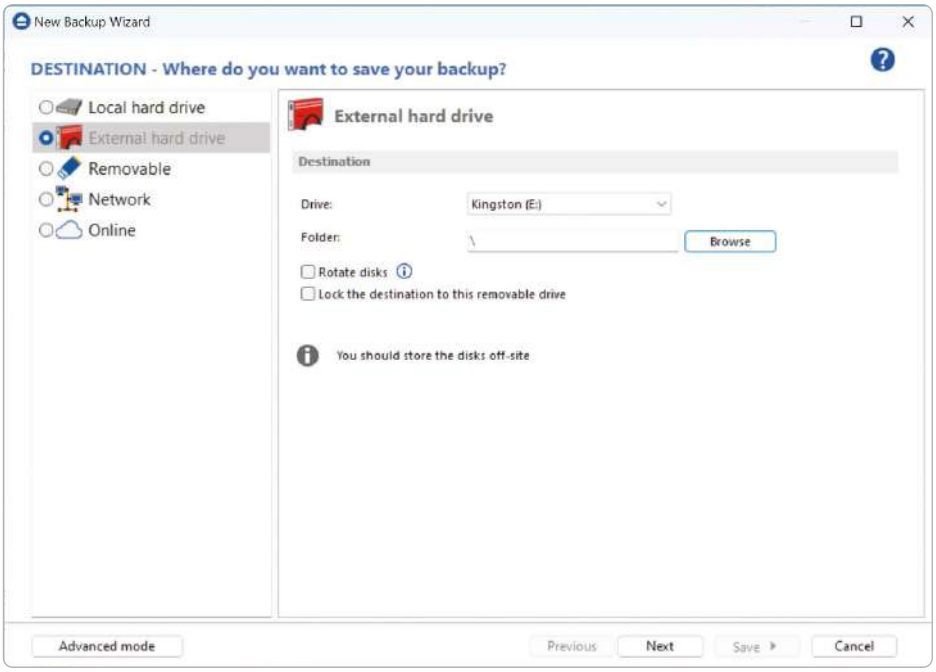
Total value this month £116

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

Backup4All 9.9 Lite

- **Full product worth £28**
- **backup4all.com**

REQUIRES Windows 7 or later; 150MB hard drive space; online registration



This feature-rich backup software makes it easy to archive your important data and keep it secured for years to come. The Lite version included with this issue's downloads is the perfect solution for home users, balancing ease of use with the flexibility to define your own backup routine.

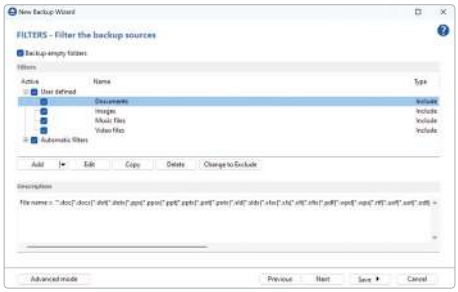
An intuitive interface walks you through the process of defining your backup set, allowing you to select the drive you want to secure and define which type of files you want to include in the archive. You can create separate backups for, say, documents, photos, videos and audio files, and restore them in bulk – or retrieve a single file without having to navigate through all of the others. Backup4All's plugins make it easy to identify files used by specific software suites, so you don't have to guess and risk missing an important file. The Ableton plugin, for example, backs up Ableton user files, common files and projects.

You can define multiple backup sets and run them manually or to your own schedules. You could, for example, back up essential financial documents every night but only secure your music files, which don't change so frequently, every week or month. Schedules are managed through Backup4All itself and use Windows Scheduler to execute.

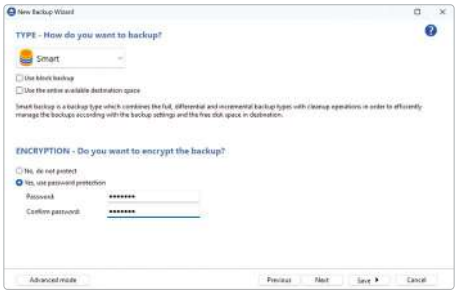
Backups can be written to and restored from USB media drives, network drives and local hard drives. You can even back up open files, which should prevent failures if you're working on a document that's part of a backup set when your scheduled job becomes due.

Naturally, as well as creating complete backups, you can perform incremental backups. These minimise the size of each archive and reduce the time taken to secure your files.

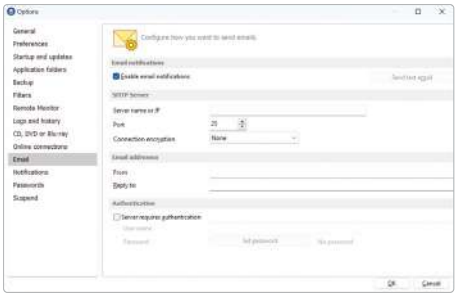
As you become more familiar with Backup4All, you can dig into the advanced settings, which will give you greater control over the contents of your archives and the full range of options for this flexible, extensible backup suite that takes much of the pain out of keeping your files secure.



ABOVE Filters help you locate and back up all files of particular types, saving you time and reducing the risk that any items will be missed



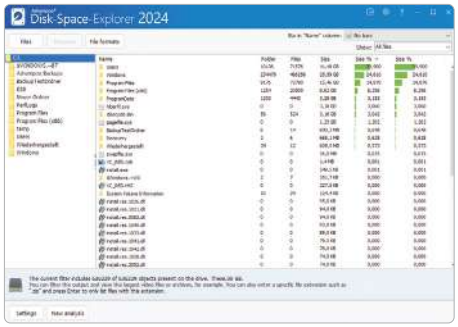
ABOVE Smart backups can save space on your destination drive, while password protection keeps your data safe from prying eyes



ABOVE If you need to keep an eye on things while away from your computer, Backup4All can send email notifications of errors and completed jobs

Disk Space Explorer 2024

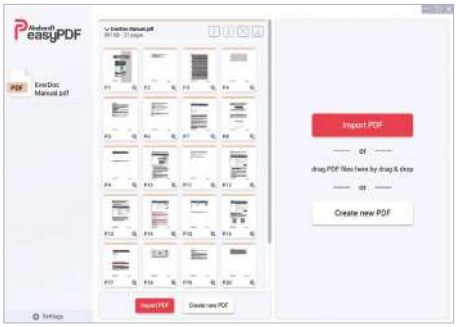
- Search your drives for resource-hogging folders and files you no longer need
- Filter by file type, create your own custom filters and generate graphical charts to visualise the results
- Reclaiming space may mean you don't need to invest in costly additional storage



Full product worth £29 ashampoo.com
REQUIRES Windows 10 or later; 50MB hard drive space; online registration

EasyPDF 2024

- Merge multiple PDFs – and add and remove pages – with simple drag and drop operations
- Enlarge individual pages for optimal overviews, and colour-code PDFs and pages
- Create a new PDF from multiple files, and use the undo function to wind back unintended edits



Full product worth £10 abelssoft.com
REQUIRES Windows 7 or later; 50MB hard drive space; online registration

Guardian of Data 3

Full product worth £19 ascomp.de
REQUIRES Windows 7 or later; 50MB hard drive space; online registration

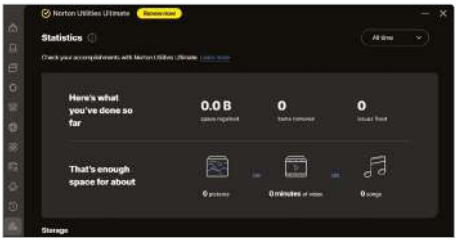
- Apply 256-bit AES encryption to your documents to keep your secrets safe
- Secure your documents quickly and easily using the encryption option that's added to the right-click Windows menu
- Create self-extracting files so correspondents don't need their own copy of the software

Audials Radio 2024.1 SE

Full product worth £15 audials.com
REQUIRES Windows 7 or later; 3GB hard drive space; online registration

- Tune into online radio stations from around the world and find new music by searching by station name or genre
- Save favourite stations for future reference and scroll back through earlier broadcasts
- Pool your music from iTunes and other sources into one easy-to-manage location

Norton Utilities Ultimate 2024



Ten-device, one-year licence worth £15
norton.com REQUIRES Windows 7 or later; 100MB hard drive space; online registration

- Detects PC problems, including wasted space, Registry issues and more
- Repair everything with a single click or work through each remedy in turn
- Includes five cleanup tools, memory optimiser, startup accelerator and drive defragmenter

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Panasonic Toughbook 33 MK3 Detachable

It has both physical and metaphorical rough edges, but is a big step up in power for rugged Windows tablets

SCORE ★★★★☆

PRICE £2,975 (£3,570 inc VAT)
from ultima-computers.co.uk

Last month I reviewed the Toughbook 55 MK3 (*see issue 358, p56*), a rugged laptop that offers almost 24 hours of battery life, and now it's the turn of its little tablet brother: the Toughbook 33 MK3. I use the word little with caution, for as a standalone tablet it's no lightweight at 1.6kg, and once you attach its keyboard base it weighs the same 2.8kg as the 55 while being significantly bulkier.

But if the Toughbook 55's secret weapon is its portable power, the Toughbook 33 is all about versatility. The 12th gen U series chips don't pack as much grunt as the 13th gen P series units found in its sibling – primarily due to having two P-cores rather than six – but this Windows 11 Pro tablet is still faster than any other rugged tablet we've tested and can tackle any task its target user is likely to face. Just don't expect it to race through video edits or 3D renders.

Naturally, it's built to withstand considerable levels of abuse. Where Samsung says its Active5 tablet (*see opposite*) has been "designed to meet" a selection of MIL-STD-810H tests, the Toughbook 33 has passed every single one of them and will survive in far more extreme temperatures, altitudes and levels of humidity. It's certified to IP65 standards, which means it's dust-tight and fine in rain, but not designed for immersion in water.

ABOVE The Toughbook 33 is a highly versatile, rugged tablet

It's also packed with ports, which you can unscrew and replace. My review unit shipped with a Thunderbolt 4/USB-C port, USB-A, HDMI 2.1, serial and gigabit Ethernet, and they're all protected by chunky covers with water-tight seals. These ports are spread over the top and left side (if viewed in landscape mode), with the right home to the DC input for the 350g power supply and a stylus.

This is a stubby little thing that measures 4.5in from tip to base. It doesn't feel great inside a thick glove, and people with big hands may find it fiddly, but most people should get along with it fine. The majority of the time you'll use your fingers – in gloves or without – to prod away at the screen, which has a star attraction: its ludicrously high levels of brightness, peaking at 1,244cd/m² in our tests. It's also nice to see a sharp 2,150 x 1,440 resolution across its 12in diagonal, and while 68% coverage of the sRGB gamut (and an average Delta E of 2.81) is poor for a consumer device, that's absolutely fine for a workhorse such as this. It certainly doesn't look drab.

Below the screen you'll find a selection of handy physical buttons: two programmable, two for volume, one for Windows and the power button. I also appreciated the separate LED indicators for the two batteries – orange while they're charging, green when full – and naturally the batteries are hot-swappable. Buy the charging stand and you need never worry about the fact they only survived 6hrs 41mins in our light-use battery tests; that's not each, that's together. But you can double that, roughly, if you choose the six-cell batteries rather than the three-cell units in my tablet.

Due to the thickness of the base unit I expected it to include space for batteries, but its main use is to expand the selection of ports – again, they're customisable – and to provide a keyboard. This offers a far better typing action than you have any right to expect for a tablet add-on, although there are space constraints that lead to a narrow, single-height Enter key and one of the world's tiniest touchpads (78 x 40mm). It also took me a few attempts to make the screen snap securely into place, meaning I came very close to an inadvertent drop test as the tablet slid out of the housing. I'm surprised that Panasonic hadn't made the locking mechanism more obvious, but once the tablet is locked in place you can confidently use the Toughbook 33 as a notebook – complete with a carry handle.

"This Windows 11 Pro tablet can tackle any task its target user is likely to face. It's one of the fastest rugged tablets you can buy"

As always with Toughbooks, the final consideration is cost. Buy the exact spec listed here (which includes support for 4G) and it's close to £3,000 exc VAT, and if you want 32GB of RAM and six-cell batteries then you're looking at £3,285 exc VAT. Choosing a 1TB SSD rather than 512GB costs an extra £345. But if there's one thing you can be confident of, it's that this tablet is built to last under even the toughest conditions, so your investment should survive for several years. **TIM DANTON**

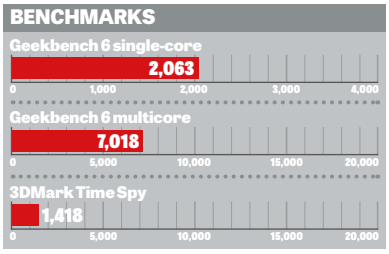
LEFT This tablet is built to withstand extreme conditions

BELOW A convenient carry handle makes it easy to transport

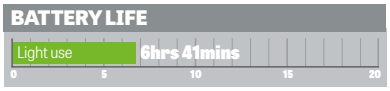
SPECIFICATIONS

Tablet: 10-core (2 P-cores, 8 E-cores) Intel Core 15-1245U vPro processor • Intel Iris Xe graphics • 16GB LPDDR4-4267 RAM • 12in 60Hz IPS touchscreen, 2,160 x 1,440 resolution • IP55 digitiser pen • 512GB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.1 • 4G • GPS • 1080p IR webcam • 8MP rear camera • Thunderbolt 4/USB-C 4 • USB-A 3.2 Gen 1 • HDMI 2.1 • serial port • gigabit Ethernet • 2 x 22Wh batteries • Windows 11 Pro • 313 x 235 x 24mm (WDH) • 1.6kg. **Keyboard:** SD/SDXC card reader • 2 x USB-A 3.2 Gen 1 • USB-A • HDMI 2.1 • serial port • serial port • gigabit Ethernet • 309 x 290 x 52mm (WDH) • 1.2kg. **Bundle:** 3yr limited warranty • part code CF-33UZ02ABE

BENCHMARKS



BATTERY LIFE



Samsung Galaxy Tab Active5 5G

If Android meets your working needs, this rugged tablet is great value and surprisingly versatile

SCORE ★★★★☆

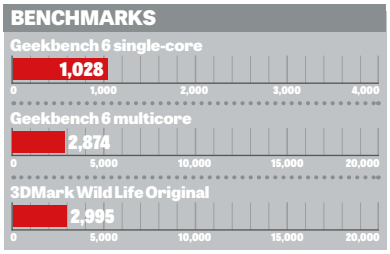
PRICE £424 (£509 inc VAT)
from samsung.com

PC PRO RECOMMENDED

It turns out that "tablet" isn't a great word in terms of precise description. The Galaxy Active5 5G tablet has more differences than similarities to either of the two other tablets we review this month – the Lenovo Tab P12 Pro (*see p64*) and the Panasonic Toughbook 33 MK3 opposite. If anything, this compact 8in device has more in common with a phone, including support for 5G and a slim design.

But this is no consumer device. It's a rugged tablet designed for hard knocks, with the promise of drop protection from 1.8m in the bundled case, an IP68 rating against dust and water ingress, and Samsung even claims that it has been tested to meet MIL-STD-810 standards – including altitude, humidity and vibration. There are a couple of practical measures, too, such as the fact you can wipe it down with sanitiser and replace the battery.

I suspect that most people who buy this tablet – and Samsung has manufacturing, healthcare and retail in its sights – will keep the it in the supplied case. This adds to the bulk and weight, taking the Active5 from 10.1mm thick to 12.4mm and from 433g to 525g, but in return you get an added layer of protection and a slot for the bundled S Pen stylus. This fits so snugly that I had to wrench it out on my first attempt, so this isn't for the feeble fingered.



This particular iteration of the S Pen is a thicker stylus than Samsung's norm, which means it's easier to use in gloved hands. It's nice to see that the touchscreen – which is protected by Gorilla Glass 5 – supports touch with gloves, too, as not all rugged tablets do. You can also keep using the touchscreen in wet conditions, with adjustments available to sensitivity as required.

The panel itself is a 120Hz IPS affair, with a 1,920 x 1,200 resolution equating to 283ppi – low for modern phones but reasonable for mid-range tablets. More importantly, it's sharp enough that I found it pleasant to use, and it breezed our technical tests by covering 89% of the DCI-P3 space with an average Delta E of 0.69, so colour coverage and accuracy are excellent. Contrast is a similarly strong 1,466:1, while I measured a peak brightness of 613cd/m². This meant that I could easily see information under bright sunlight with the adaptive brightness mode active. But this isn't a tablet for film addicts; the single speaker has plenty of volume but little nuance.

LEFT POGO pins are provided for docks

ABOVE The 8in IPS display is sharp and colour-accurate

LEFT Samsung's S Pen stylus fits snugly into the protective cover

Don't expect the last word in speed, either, with a Samsung Exynos 1380 processor inside. This sits in the mid-range, with solid returns in Geekbench 6 – a shade faster than the Lenovo – but a stuttering 18fps (2,995) in 3DMark's Wild Life Original that dropped to 5fps (845) in the Extreme version of that test. Did I mention that this isn't a tablet designed for entertainment?

You should get decent battery life, at least, as it lasted 19hrs 52mins in a 1080p video-rundown test. While you can charge via the USB-C port, Samsung provides POGO pins for docks (perfect for use in vehicles or if you need to charge several tablets at once) and the option to run in No Battery Mode to avoid overheating if you must leave it constantly on – or if it's in a hot environment and you're worried about the battery's health.

Further practicality comes via the large, easy-to-hit physical buttons: three on the front (active apps, home, back) for navigation, up and down volume controls, the power button and the so-called Active key. This can be programmed per app, but in general use it activates the pair of cameras: a 13MP unit at the rear, a 5MP sensor on the front. Will you be wowed by their detail capture and low-light performance? You will not. But in decent light conditions they take adequate snaps, so long as you don't zoom into details.

At least they won't occupy much of this device's 128GB of storage, which is expandable via the combo nano-SIM/SD card tray that sits on the opposite side to the volume controls.

"It's nice to see that the touchscreen – which is protected by Gorilla Glass 5 – supports touch with gloves, as not all rugged tablets do"

Samsung sweetens the long-term deal with the promise of support for four generations of Android OS – it ships with Android 14 – and five years of security updates. And when you consider the quality on offer for the price, that pushes it safely into Recommended territory. **TIM DANTON**

SPECIFICATIONS

8-core ARMv8 processor • Mali-G768 graphics • 6GB RAM • 8in 120Hz touchscreen IPS display, 1,920 x 1,200 resolution • 128GB storage • microSD card slot • IP68 • S Pen • 13MP rear camera • 5MP front camera • 5G • Wi-Fi 6 • Bluetooth 5.3 • 3.5mm jack • POGO pins • USB-C 2 • 5,050mAh battery • Android 14 with One UI 6 • Samsung Knox • 127 x 10.1 x 214mm (WDH) • 433g • 1yr warranty

Kobo Clara BW

Better contrast and response times from the E Ink Carta 1300 screen make this the best 6in e-reader available

SCORE ★★★★☆

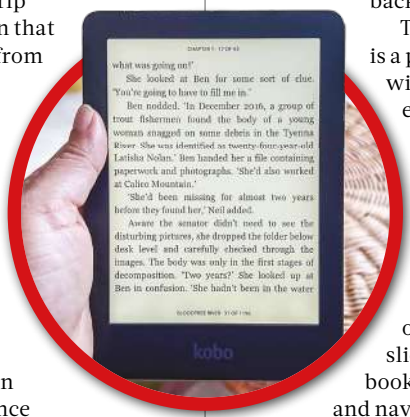
PRICE £100 (£120 inc VAT)
from uk.kobobooks.com

PC PRO RECOMMENDED

Kobo's Clara BW is the first e-reader we've seen to use E Ink's Carta 1300 technology. This keeps the screen resolution at a sharp 300ppi while improving both refresh time and contrast over previous generations.

Despite the cutting-edge display, the Clara BW is very affordable: at £120, it's £40 cheaper than the Kindle Paperwhite. And, in an industry first, Kobo has partnered with iFixit to provide spare parts and repair kits, so if you're confident with a screwdriver you can replace the battery or fix a smashed case without having to ditch the entire thing. A body that's made from 85% recycled plastic adds to its sustainability claims, and the packaging is recycled and recyclable, with biodegradable soy ink printing.

Design-wise, the Clara BW has less to shout about. It looks very generic, with a black case, raised side bezels for an easy grip and a sunken screen that helps reduce glare from overhead lights. While it won't win any design awards, at 174g it's light enough to hold comfortably for long periods, and the 6in screen means it's small enough to carry wherever you go. An IPX8 water-resistance rating means you need not worry about getting caught in the rain or even dropping it in the bath.



The standout feature is the display. It's noticeably more responsive than previous models, with bolder contrast that makes text look clearer and sharper (even though the resolution hasn't changed). I tried the Clara BW side by side with a regular Amazon Kindle, and the Kobo was the obvious winner for readability, no matter how small or large I set the font size, or how bright I set the front light.

On that note, Kobo's proprietary ComfortLight Pro technology combines white and amber LEDs, allowing you to adjust the colour temperature to suit your surroundings, or let the software automatically set it according to the time of day. There's also a dark mode, which shows white text on a black background.

The whole interface is a pleasure to use, with friendly, easy-to-navigate controls. A faster refresh rate (25% faster than previous generations, says Kobo) contributes to an overall sense of slickness: opening books, turning pages and navigating around the interface all felt beautifully responsive on the Clara BW, and I could enter text via the on-screen keyboard with no distracting lag.

One Kobo-specific feature I particularly like is the Activity monitor, which tracks the total time you've spent reading. Badges and rewards are unlocked as you hit specific targets and milestones, encouraging you to keep reading. Detailed statistics are only available for titles you've bought from the Kobo Store, though, and that might be a fraction of your digital library, as the platform is open to a huge range of sources. You can easily import titles over a drag-and-drop USB connection, with native support for EPUB and MOBI formats, plus PDFs, text files and two different comic-book formats. Font support is excellent, and if you want to add specific typefaces (such as Amazon's Bookerly and Ember fonts) you can easily upload those, too.

As with all Kobo e-readers, OverDrive and Pocket support are baked in. The former allows you to borrow titles from a public library – although check first, as not all UK libraries support OverDrive. Pocket lets you conveniently save articles from your web browser to your Kobo with a click, ready to read offline at a future date.

There are a few features missing. You can connect a Bluetooth speaker or headset to listen to audiobooks sourced from the Kobo Store, but you can't play your own audio content. There's also no support for transferring content to the device via Dropbox or Google Drive – these services are only supported on more premium Kobo models.

The Clara BW uses the same 1,500mAh battery as other Kobo readers, so it's no surprise that battery life is pretty similar. During testing, I kept the Clara BW at 15% brightness with Wi-Fi enabled, and was able to read for approximately two hours each day for 35 days before needing to recharge. Listening to audiobooks will run it down faster, but it doesn't take long to top up: I got from 19% to a full charge in less than an hour.

"I tried the Clara BW side by side with a regular Amazon Kindle, and the Kobo was the clear winner for readability"

Without a doubt, the Clara BW raises the bar for e-readers. Those who enjoy comic books or colour illustrations will prefer the £140 Kobo Clara Colour, or for £200 you can buy the Libra Colour, which adds note-taking capabilities (*see issue 357, p70*). But if you're mostly interested in plain text, the Clara BW's next-generation E Ink display and repairability puts it well ahead of its mono rivals.

SHARMISHTA SARKAR

ABOVE The design may be utilitarian, but the quality is unrivalled

LEFT ComfortLight Pro technology means you can adjust the colour balance

BELOW The Clara BW supports a wide range of ebook formats

SPECIFICATIONS

6in E Ink Carta 1300 screen • 300ppi • 16GB storage • 1,500mAh battery • IPX8 • Wi-Fi 4 • Bluetooth • USB-C • supports Kobo audiobooks, EPUB, EPUB3, PDF and 12 more file formats • 112 x 9.2 x 160mm (WDH) • 174g • 1yr limited warranty

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Elegoo Saturn 4 Ultra

A brilliant advert for resin-based 3D printing, with a host of features that make it easy to obtain great results

SCORE ★★★★★

PRICE £296 (£355 inc VAT)
from uk.elegoo.com

In the world of 3D printing, resin-based stereolithography (SLA) is less popular than squirty thermoplastics – probably because it involves a manual finishing process and toxic materials. However, Elegoo's latest resin printer is both easy to use and produces excellent results.

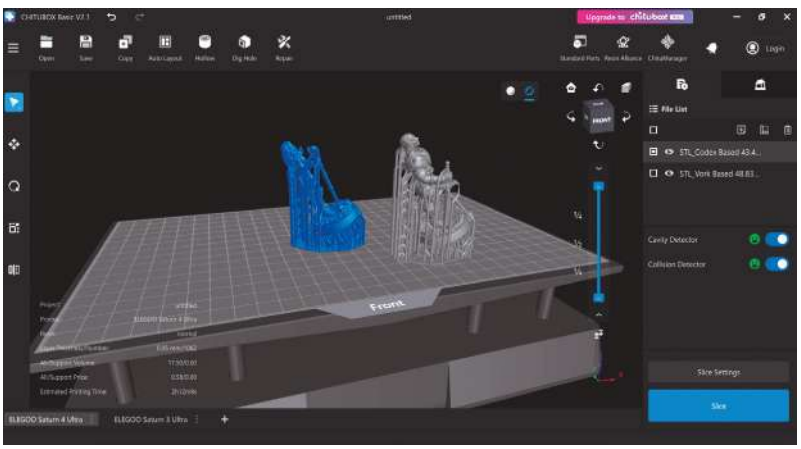
The package comes with everything you need to get started. The printer arrives fully assembled, and the box contains a metal scraper for the build plate, a plastic scraper for the release film, paper funnels, disposable gloves, disposable masks and a set of Allen keys. There's also a printed manual and USB flash drive, preloaded with the Chitubox Basic slicing software, a PDF of the manual and pre-sliced test prints.

Gloves and masks aren't included just for fun: uncured resin is dangerous, and the solvents used to clean your prints can irritate the skin. You should also wear safety glasses and ensure your room is well ventilated to avoid inhaling fumes.

That's despite the striking hinged hood, which adds to the Saturn 4 Ultra's modern looks. Most resin printers use a lift-off box-type hood, which is bulky and unwieldy. Here, the hood can be swung easily upward with one hand – a huge improvement in convenience and usability. I only wish there were a handle on the lid: opening and closing it after handling uncured resin can leave unwanted smudges.

The 4in touchscreen is off centre in an unusual portrait orientation, but you'll quickly appreciate the intuitive interface and scratch-resistant screen protector.

Printing is delightfully easy. At the computer end, the Chitubox software does everything you need, automatically adding supports as needed, plus hollowing and drainage holes to conserve resin. And the printer itself has several automatic features to help you get successful results; unlike other resin printers, it doesn't require manual calibration –a mechanical sensor detects how well the plate and glass are fitting together and automatically adjusts the print accordingly. It auto-levels itself, too, so there's no fumbling around with a piece of paper and a hex key.



LEFT The Chitubox software makes everything simple

ABOVE The printer comes fully assembled and is easy to use

PC PRO RECOMMENDED

LEFT Test models came out with beautifully clear details

Internal sensors ensure you don't run out of print material and detect if bits of a failed model are stuck to the vat. There's a handy camera for monitoring the progress of your prints, although Chitu Manager must be switched on for this to work, which isn't explained in the directions. The printer can also detect an empty plate, but only once the plate is above the vat, at a height of around 50mm. Warp detection isn't brilliant, either: it will alert you if things go seriously wrong, but didn't raise the alarm when one of my prints started to peel off the bed.

The build plate is laser-etched and it holds prints well while being fairly easy to scrape off. The top of the plate isn't quite sloped enough to get all the resin back into the vat conveniently, but the vat itself has an excellent no-drip pour spout for getting surplus resin back into the bottle.

The Saturn 4 Ultra isn't particularly fast: my test print of Wekster's Rocket took 3hrs 13mins to print with default settings, which is a pretty average speed. However, its quality is superb. The printer boasts an ultra-fine precision of 19 microns on the X axis, and layer lines are simply invisible; my model came out with beautifully clear details around the teeth on Rocket, and the vines on Baby Groot.

I then tried loading the Saturn 4 Ultra with Phrozen's Aqua Grey 8K to see how it would do with a different brand of resin – and I was happy to see it had no trouble at all. This D&D miniature again printed very cleanly, with excellent detail, in 2hrs 12mins.

Before you can admire your prints, you'll need to wash them with isopropyl alcohol and then cure them under UV light. You can do this by popping them into a UV curing station for a few minutes to harden, or leaving them outside in bright sunlight for a few hours. It's easiest to remove supports before doing this, while they're still soft.

"For the price, the Elegoo Saturn 4 Ultra is an astounding 3D printer. It makes an ideal first resin machine"

For the price, the Elegoo Saturn 4 Ultra is an astounding 3D printer. Beginners might prefer a cheaper ABS filament printer, which doesn't require working with hazardous chemicals or post-print curing. But the Saturn makes an ideal first resin machine: it's reasonably priced and offers a built-in camera, ample build volume, and plenty of smart features to help you produce terrific prints.

DENISE BERTACCHI

SPECIFICATIONS

Resin print technology • up to 150mm/hr print speed • 4in touch panel • 19nm x 24nm XY resolution • 219 x 123 x 220mm build area • 327 x 329 x 548mm (WDH) • 14.5kg • 1yr limited warranty

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Honor 200 Pro

Three standout features – its portrait mode, gaming chops and huge battery – make this a desirable phone

SCORE ★★★★☆

PRICE £583 (£700 inc VAT)
from honor.com/uk

The Honor 200 Pro isn't the first premium phone to pack a great set of cameras, but it is the first to come with a set of bespoke filters developed in partnership with Studio Harcourt, the legendary Parisian portrait studio. Yes, technically these are only software effects, but they're superb ones that can help you capture striking, characterful shots.

The "Harcourt Classic" filter is most recognisable. This aims to recreate the look of the studio's signature black-and-white headshots, and the results can be stunning. With the right subjects, at least, as the photo of me below sadly shows. "Harcourt Colour" is similar, but uses a lovely warm colour palette. Both modes accentuate lens flares, and while artificial bokeh may be old hat, it's beautifully implemented here; I was impressed with how well it managed to separate wisps of hair and difficult materials from the background.

Finally, there's "Harcourt Vibrant" mode, which produces images with less of the vintage allure and more pop. It's not as distinctive as the other modes, but still nice if you want a more vibrant, modern-looking shot.

Camera trio

The hardware that makes this all possible is a 50MP main camera with a 1/1.3in sensor and optical image stabilisation (OIS). It captures impressive photos of all types, not only portraits, with the large sensor picking out clean detail even in low light. If you want to get closer to your subject you can tap a button to instantly crop in to 2x, or switch to the 2.5x telephoto lens: it too has a 50MP resolution plus OIS, so you can get away with additional digital zoom. I was very happy with the results at 5x zoom, although things visibly degrade once you move up to 10x.

The last rear-facing camera is a 12MP ultrawide sensor with a 16mm-equivalent field of view. Though not as wide as flagship phones, this captures a good amount of detail, and can focus extremely closely for macro shots. There's also a 50MP front-facing selfie camera, with a wide field of view that makes it suitable for group shots.

As well as stills, the Honor 200 Pro supports 4K video capture at up to 60fps on the main and telephoto cameras, while the ultrawide and selfie cameras max out at 30fps. The resulting videos have great stabilisation and, as usual, Honor's software has tons of features packed in, including full manual controls.

ABOVE **A sharp display, speedy CPU and great battery life make this a fine choice**

"It captures impressive shots of all types, not just portraits, with the large sensor helping it to pick out clean detail even in low light"

Sweet spot for speed

So much for photography; how does the Honor 200 Pro work as a phone? The answer is very well. It's the first handset we've seen based on the Snapdragon 8s Gen 3 chipset, the mid-price variant of Qualcomm's top-end Snapdragon 8 platform. Predictably, it's not as powerful as the premium silicon, and in benchmarks the Honor 200 Pro lags behind last year's Snapdragon 8 Gen 2-powered phones: 4,685 in the Geekbench 6 multicore test is around 500 slower than Snapdragon 8 Gen 2 phones and roughly 2,500 behind devices powered by the full Gen 3 chip. In practice, though, you'll only notice a difference if you push your phone to the limits: in day-to-day use it feels perfectly snappy. And I had no issues playing graphically demanding games such as *Wuthering Waves* at maximum settings. The phone does heat up when you give it such a demanding workload, but I never found it uncomfortable to hold.

Indeed, it sits nicely in the hand, with curved edges that make it feel slimmer than 8.2mm, and a high-gloss metal frame around the edges. The rear is made from glass with a velvety-feeling matte texture that's completely immune to fingerprints, in a choice of moonlight white, black, and ocean cyan finishes. I tried the white version, which has a tasteful marble-like pattern across the rear, while the black version has an understated uniform finish. The cyan model is the loudest, with a sweeping S-shaped curve down its dual-texture back. Whichever you choose, the most conspicuous thing about the phone is the unique oval camera surround, which – despite the French connection – is apparently inspired by the shape of Barcelona's Casa Milà.

At the front, the Honor 200 Pro has a bright, vivid display that's curved on all sides, with an adaptive refresh rate that dynamically steps between 60Hz and 120Hz. It's sharp and detailed, with fantastic colour reproduction and enough brightness to compete with the sunshine.

BELOW **The Harcourt Classic filter gives portraits a thoroughly professional look**

Soft touches

The phone runs on MagicOS 8, Honor's adaptation of Android 14, and this is a significant departure from stock Android. In places it feels more like iOS: the notification shade and quick settings menu are separated, the app drawer is disabled by default, and

ABOVE Curved edges, a metal frame and glass rear give the 200 Pro a premium feel

there's even a Dynamic Island-like feature that Honor calls Magic Capsule. As a regular Android user I found all of this jarring at first, but I grew used to it pretty quickly – and I particularly liked the way the Magic Capsule gives quick access to media controls and timers, no matter which app is running in the foreground.

Another great feature is Honor's Magic Portal. This lets you drag a bit of text or an image to the side of your display, then quickly share or search for it in a selection of pop-up apps. I loved being able to swipe an address into Google Maps for speedy directions, or to flick to the side to launch a reverse image search.

Impressively, Honor squeezes a 5,200mAh battery pack into its svelte shell, so it will easily survive a day of heavy use, and might even run to two days of light use. It recharges quickly, too: with the included 100W wall adapter you can get from dead to fully charged in 50 minutes. Or you can invest in Honor's 66W SuperCharge stand and charge it wirelessly almost as quickly.

However you look at it, the Honor 200 Pro is an impressive phone. While its most distinctive feature is the Studio Harcourt portrait effects, it has plenty else to offer, including great battery life, super-fast charging and a new Qualcomm chipset that delivers all the performance you're likely to need for a very reasonable price. Factor in the generous 512GB of internal storage and it's an attractive alternative to similarly priced rivals such as the Samsung Galaxy S24 (*see issue 355, p72*) or Google Pixel 8 Pro (*see issue 351, p70*). **LUKE BAKER**

SPECIFICATIONS

8-core Qualcomm Snapdragon 8s Gen 3 SoC • 12GB RAM • Adreno 735 graphics • 6.8in 120Hz AMOLED screen, 1,224 x 2,800 resolution • 5G • 512GB storage • IP65 • triple 50MP/50MP/12MP rear cameras • dual 50MP/2MP front cameras • Wi-Fi 6E • Bluetooth 5.3 • NFC • 5,200mAh battery • USB-C 2 • Android 14 with MagicOS 8 • 75 x 8.2 x 163mm (WDH) • 199g • 2yr warranty

Insta360 Go 3S

A fun, tiny multifunctional 4K camera that can go where others can't, so we'll forgive minor failings

SCORE ★★★★★

PRICE Standard Bundle, £292 (£350 inc VAT) from store.insta360.com

PC PRO RECOMMENDED

ABOVE The Action Pod turns the Go 3S into a GoPro-style camera

The new Go 3S is the latest in a line of tiny action cameras by Insta360, with convenient magnetic mounting and useful accessories for hands-free operation and unique points of view. When your phone won't do or can't be risked, the tiny and fully waterproof Go 3S steps up. Both the camera and the Action Pod (which comes as part of the Standard Bundle and essentially turns the Go 3S into a GoPro-style camera) are made from rigid plastic, so I'd be happy to put them in harm's way. They've already taken occasional knocks from fast-moving balls and clumsy drops, and come out unscathed.

Insta360 updates the one-year-old Go 3 with key upgrades, chiefly bumping video resolution up from 2.7K to 4K. It's also equipped with Apple Find My, which is a useful addition to a tiny 39g camera. And there's another neat trick: the Go 3S will automatically switch video aspect ratio based on whether it's horizontal or vertical when filming starts. Gesture control has been added to voice command control, so you can position the Go 3S and start recording without needing to be hands-on. You can also remotely control the Go 3S with the Insta360 app, although the dedicated user interface of the Action Pod will have you leaning to that instead of your phone.

Naturally, there are compromises compared to bulkier alternatives. Battery life from the tiny 310mAh battery is limited to 38 minutes when shooting Full HD video. That's less than its predecessor's 45 minutes and way below other action cameras, such as the GoPro Hero 12 Black and Insta360's own X4 360° camera. To counter this limit, the Go 3S can extend record times by going to sleep for video modes, such as TimeShift and Timelapse. When paired with the Action Pod, you get even more shooting options and better battery life, which is boosted to 140 minutes of 1080p video.

Virtually all the shooting modes are super simple to use and create decent footage with. Videos are sharper than before and you can see the difference compared to the Go 3. However, overall quality still lags behind the best action cams such as the Osmo Action 4 and Hero 12 Black. And although Insta360 says the Go 3S is "Dolby Vision-Ready", there's no HDR video mode, meaning you lose out on highlight and shadow detail when lighting is less than perfect. You do get an HDR option in photos, both colours and auto exposure work well, but they're capped at 12MP in 4:3 or 9MP in 16:9.

"Its versatility is unrivalled. You can attach it to a dog's collar, place it in goal during football matches and tuck it into bird houses"

ABOVE There are plenty of options for hands-free operation

However, you're buying into the Insta360 Go series for its unrivalled versatility. That's why the Go 3 was my favourite camera for FPV drones, hands-free video and first-person perspectives. You can attach it to a dog's collar, place it in goal during football matches and tuck it into bird houses.

It might not be perfect, but the Go 3S is an excellent smartphone alternative for creative filmmakers. **TIMOTHY COLEMAN**

BELOW The camera's video resolution has been bumped up to 4K

SPECIFICATIONS

4K f2.8 camera (16mm equivalent focal length) • 64GB/128GB storage • 310mAh battery • USB-C 2 • H.264 video coding • JPG, DNG, MP4 formats • 6-axis gyroscope • 26 x 54 x 25mm (WDH) (Action Pod, 64 x 48 x 30mm) • 39g (Action Pod, 96g) • 1yr limited warranty

EVERYDAY LAPTOPS FROM £450

WHETHER YOU'RE LOOKING FOR A RUNAROUND OR A RACING CAR, ONE OF THESE LAPTOPS WILL BE THE PERFECT CHOICE

This month we look at everyday laptops. And that begs one obvious question: what is an everyday laptop? The answer depends on you. What everyday use looks like differs from person to person, so our brief to manufacturers wasn't overly stringent, and the laptops on test cover a wide range of needs.

Some users may prefer a compact, light laptop with excellent battery life, and we have five varied options here. The Samsung Galaxy Book4 is a great example of this, costing £949 (usually discounted to £899) yet looking like a far more glamorous, expensive machine. Or you could consider the flexible and equally eye-catching HP Envy x360.

Others will prioritise power, perhaps looking for gaming potential, and again we have three fine choices on test. Turn to the gaming graphs on p94 and you'll see an instant comparison of the relative power of Nvidia's RTX 2050, 3050 Ti and 4060 chips, which sit in the Acer Aspire 14, HP Victus 15 and MSI Cyborg 15 laptops respectively.

Then there's the small matter of money, and again we've attempted to cover the spectrum, with prices ranging from £450 to £1,000. The old adage of "you get what you pay for" still applies, but don't ignore bargains such as the Acer Aspire Go 14.

We focus on Windows laptops here, but didn't want to entirely overlook the Chromebook options (at this price, the only MacBook choice is the £999 M2 MacBook Air (*see issue 336, p50*), which is now almost two years old). The Lenovo IdeaPad Flex 5i serves as a taster for Google's OS, but there are plenty of options – as you will see if you read our Chromebooks group test from three months ago (*see issue 356, p76*).

All of which means that you have plenty of choice. And don't forget that we review laptops of all prices in *PC Pro* every single month.

CONTRIBUTOR: KEVIN POCOCK

CONTENTS





	LABS WINNER			RECOMMENDED	
	Acer Aspire 14	**Acer Aspire Go 14**	**Asus Vivobook 15 (X1504)**	**HP Envy x360 13in**	**HP Victus 15**
Overall rating	★★★★★	★★★★☆	★★★☆☆	★★★★☆	★★★☆☆
Purchase information					
Price [1]	£708 (£850 inc VAT)	£375 (£450 inc VAT)	£500 (£600 inc VAT)	£833 (£1,000 inc VAT)	£750 (£900 inc VAT)
Supplier	acer.com	acer.com	uk.store.asus.com	hp.com/uk	hp.com/uk
Part code	NX.KSVEK.005 [2]	NX.KSKEK.013 [2]	90NB1022-M00FX0	bf0047na	6P128EA#ABU
Dimensions (WDH)	320 x 226 x 18.9mm	320 x 226 x 18.9mm	360 x 233 x 17.9mm	298 x 215 x 16mm	358 x 255 x 23mm
Weight	1.5kg	1.5kg	1.7kg	1.4kg	2.3kg
Service and support					
Warranty [3]	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
Manufacturer support/ reliability score [4]	82%/90%	82%/90%	80%/88%	75%/84%	75%/84%
Core components					
Processor	Intel Core 5 processor 120U [2]	AMD Ryzen 3 7320U [2]	Intel Core i5-1235U	Intel Core i7-1250U	AMD Ryzen 7 5800H
Cores [5]	2 x P-cores, 8 x E-cores	4	2 x P-cores, 8 x E-cores	2 x P-cores, 8 x E-cores	8
Threads	12	8	12	12	16
Maximum CPU speed	5GHz	4.1GHz	4.4GHz	4.7GHz	4.4GHz
Supplied RAM	16GB [2]	8GB	16GB	16GB	8GB
Empty RAM socket	✓	✗	✗	✗	✗
Primary GPU	Nvidia GeForce RTX 2050	AMD Radeon Graphics	Intel Iris Xe	Intel Iris Xe	Nvidia GeForce RTX 3050 Ti
Display					
Size and technology	14in IPS	14in IPS	15.6in IPS	13.3in IPS	15.6in IPS
Resolution	1,920 x 1,080	1,920 x 1,200	1,920 x 1,080	1,920 x 1,200	1,920 x 1,080
Pixel density	157ppi	157ppi	141ppi	168ppi	141ppi
Frequency	60Hz	60Hz	60Hz	60Hz	144Hz
Touchscreen	✗	✗	✗	✓	✗
Glossy or matte?	Matte	Matte	Matte	Glossy	Matte
Storage					
Model	Kingston OM8PGP4	SK hynix [2]	Intel 670p Series	SK hynix bc711	WD SN730
PCI-E generation	4	4	3	3	3
Capacity	256GB	256GB	512GB	512GB	512GB
Empty SSD socket	✗	✗	✗	✗	✗
Battery & charger					
Battery capacity	50Wh	53Wh	42Wh	66Wh	70Wh
Charger wattage	65W	65W	45W	65W	200W
Charger weight	460g	290g	260g	310g	620g
Charging options	AC, USB-C	AC, USB-C	AC	USB-C	AC, USB-C
Webcam					
Maximum video resolution	1080p	1080p	1080p	1080p	1080p
Privacy cover	✗	✗	✓	✗	✗
Ports & connectivity					
Wireless standard	Wi-Fi 6E	Wi-Fi 6	Wi-Fi 6E	Wi-Fi 6E	Wi-Fi 6
Bluetooth	Bluetooth 5.3	Bluetooth 5.1	Bluetooth 5.3	Bluetooth 5.3	Bluetooth 5.3
HDMI	HDMI 2.1	HDMI 1.4	HDMI 1.4	✗	HDMI 2.1
USB-C	1 x USB 4/Thunderbolt 4	1 x USB 3.2 Gen 2	1 x USB 3.2 Gen 1	2 x USB 4/Thunderbolt 4	1 x USB 3.2 Gen 1
USB-A	2 x USB 3.2 Gen 1	2 x USB 3.2 Gen 1	2 x USB 3.2 Gen 1, 1 x USB 2	2 x USB 3.2 Gen 1	2 x USB 3.2 Gen 1
SD card reader	✗	✗	✗	✓ (microSD)	✓ (SD)
3.5mm audio jack	✓	✓	✓	✓	✓
Other features					
Backlit keyboard (brightness levels)	✓ (2)	✗	✗	✓ (3)	✗
Touchpad dimensions (WH)	105 x 65mm	105 x 65mm	105 x 73mm	115 x 75mm	125 x 80mm
Fingerprint reader	✓	✗	✗	✗	✗
Other	✗	✗	✗	✗	✗
Supplied OS	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home

[1] Price is correct at time of going to press. [2] Acer supplied early production samples with different core specs, as detailed in the reviews. The listed specs match what can be bought. [3] Warranty is for mainland UK only. [4] Laptop support/reliability rating in reader-voted *PC Pro* Excellence Awards 2023. Where N/A, companies didn't receive enough feedback to be rated. See issue 351, p26. [5] P-cores are performance cores, E-cores are efficiency cores.

RECOMMENDED

Huawei MateBook D16

★★★★☆

£833 (£1,000 inc VAT)	
huawei.com	
MCLG-X	
357 x 249 x 17mm	
1.72kg	
1yr RTB	
71%/91%	
Intel Core i9-13900H	
6 x P-cores, 8 x E-cores	
20	
5.4GHz	
16GB	
✗	
Intel Iris Xe	
16in IPS	
1,920 x 1,200	
141ppi	
60Hz	
✗	
Matte	
Unbranded	
4	
1TB	
✗	
70Wh	
65W	
200g	
USB-C	
1080p	
✗	
Wi-Fi 6	
Bluetooth 5.1	
HDMI 2.1	
1 x USB 3.2 Gen 1	
1 x USB-A 3.2 Gen 1, 1 x USB-A 2	
✗	
✓	
✓ (2)	
125 x 73mm	
✓	
✗	
Windows 11 Home	

Lenovo ThinkPad E16 Gen 1

★★★★☆

£696 (£835 inc VAT)	
lenovo.com	
N/A	
356 x 248 x 19.9mm	
1.8kg	
1yr RTB	
80%/87%	
AMD Ryzen 5 7430U	
6	
12	
4.3GHz	
16GB	
✓	
AMD Radeon Graphics	
16in IPS	
1,920 x 1,200	
141ppi	
60Hz	
✗	
Matte	
WD SN740	
4	
1TB	
✗	
47Wh	
65W	
335g	
USB-C	
1080p	
✗	
Wi-Fi 6E	
Bluetooth 5.3	
HDMI 1.4	
1 x USB-C 3.2 Gen 2, 1 x USB-C 3.2 Gen 1	
2 x USB-A 3.2 Gen 1	
✗	
✓	
✓ (2)	
115 x 68mm	
✓	
Ethernet port	
Windows 11 Pro	

MSI Cyborg 15 A12VF

★★★★☆

£741 (£889 inc VAT)	
very.co.uk	
A12VF-027UK	
359 x 250 x 29.5mm	
2kg	
1yr RTB	
87%/90%	
Intel Core i7-12650H	
6 x P-cores, 4 x E-cores	
16	
4.7GHz	
16GB	
✗	
Nvidia GeForce RTX 4060	
15.6in IPS	
1,920 x 1,080	
141ppi	
144Hz	
✗	
Matte	
Samsung MZVL4512HBLU	
4	
512GB	
✗	
54Wh	
Not stated	
490g	
AC	
1080p	
✗	
Wi-Fi 6	
Bluetooth 5.2	
HDMI 2.1	
1 x USB 3.2 Gen 1	
2 x USB 3.2 Gen 1	
✗	
✓	
✓ (3)	
120 x 75mm	
✗	
Ethernet port	
Windows 11 Home	

RECOMMENDED

MSI Prestige 13 Evo

★★★★☆

£833 (£999 inc VAT)	
currys.co.uk	
A13M-038UK	
299 x 210 x 16.9mm	
1kg	
1yr RTB	
87%/90%	
Intel Core i7-1360P	
4 x P-cores, 8 x E-cores	
12	
5GHz	
16GB	
✓	
Intel Iris Xe	
13.3in IPS	
1,920 x 1,200	
168ppi	
60Hz	
✗	
Matte	
Samsung PM9A1	
4	
1TB	
✗	
75Wh	
65W	
340g	
AC, USB-C	
1080p	
✓	
Wi-Fi 6E	
Bluetooth 5.3	
HDMI 2.1	
2 x USB 4/Thunderbolt 4	
1 x USB 3.2 Gen 1	
✓ (microSD)	
✓	
✓ (3)	
120 x 73mm	
✓	
✗	
Windows 11 Home	

Samsung Galaxy Book4

★★★★☆

£790 (£949 inc VAT)	
samsung.com	
NP750XGK-KG1UK	
357 x 229 x 15.4mm	
1.6kg	
1yr RTB	
79%/83%	
Intel Core 7 processor 150U	
2 x P-cores, 8 x E-cores	
10	
5.4GHz	
8GB	
✗	
Intel Graphics	
15.6in IPS	
1,920 x 1,080	
141ppi	
60Hz	
✗	
Matte	
SSSTC CL4-8D512	
4	
512GB	
✓	
54Wh	
45W	
160g	
USB-C	
1080p	
✗	
Wi-Fi 6	
Bluetooth 5.2	
HDMI (not stated)	
2 x USB 3.2 (Gen not stated)	
2 x USB 3.2 (Gen not stated)	
✓ (microSD)	
✓	
✗	
120 x 85mm	
✗	
Ethernet port	
Windows 11 Home	

How do you choose a laptop for everyday use?

Whether your focus is life admin, productivity or entertainment, here are the key things to consider when making your choice

Every user has differing daily needs, not to mention differing budgets, so we're not going to try to guide you precisely to your perfect laptop. Hopefully, our reviews will help you on that front. Instead, these two pages should help you identify your must-haves versus your nice-to-haves. We'll start with the literal core component: the processor.

Everyday performance

There are so many processor options that it's almost impossible to know where to begin. So we'll keep it simple to start with: for everyday usage, Intel's Core i5 and AMD's Ryzen 5 chips are great mid-range choices. However, Core i7 and Ryzen 7 options will result a more responsive laptop and achieve faster results when tackling tougher tasks, particularly creative work, video and photo editing, and coding. A Core i3 or Ryzen 3 may be sluggish, while a Core i9 or Ryzen 9 is unnecessary unless you really want top performance.

So that's the simple explanation. To make things more complicated, Intel has just changed the naming system of its processors. It now offers Core Ultra chips, all of which include a neural processing unit (NPU). Right now, the biggest benefit is during video calls as it handles background effects fantastically and can also help reduce noise, but we expect NPUs to become gradually more useful as Windows and apps evolve to take advantage of them. You can choose Ultra 5, Ultra 7 and Ultra 9 versions, which map to the previous Intel chips in terms of rough power levels.

ABOVE Regularly on the move? 13in laptops are best for portability

BELOW Touchscreens can be useful on convertible laptops

Notably, none of the laptops on test includes a processor with an NPU inside (AMD also produces chips with an NPU, which it denotes by saying the processor includes "Ryzen AI"). At the moment, it's niche and not a vital inclusion, and both AMD and Intel charge a premium for this feature.

For RAM, more laptops are opting for 16GB, but 8GB is fine for most uses if you want to keep costs down.

Gaming potential

Out of the ten laptops on test, three include so-called discrete graphics chips (or GPUs). These are the Acer Aspire 14, HP Victus 15 and MSI Cyborg 15, each of which includes an Nvidia graphics chip. You can see their respective performance in our gaming benchmark graphs on p94, and as is self-evident these add gaming prowess compared to the graphics built into the processor.

Dedicated GPUs are also useful for some creative tasks – such as applying effects in Photoshop, video editing and rendering 3D models – but are rarely used in day-to-day tasks such as office work. It should also be said that some recent integrated graphics chips are good enough to play less demanding 3D games and help out in creative tasks, so don't dismiss (for example) the power of Intel's Iris Xe graphics.

How big should you go?

Depending on your everyday needs, you can find laptops that are very portable, suitable for occasional journeys but not for daily travel, or better suited for use only at home. Similarly, if you prefer to move about your home/workspace or use your laptop on your lap, then smaller or lighter options may be better for you.

Generally, 13in models are best for portability and can weigh as little as 1kg. Recent 14in laptops are also very portable, helped by slimline designs, but you may find that 15.6in models are too heavy and bulky for your taste.

Don't think that all small laptops are slow and all big ones are fast: there is some truth to this, especially if you pick a laptop with a discrete GPU, but the biggest clue is always in the choice of processor.

But the real consideration for size is what suits you. Space matters, and if you have large hands a smaller model will be less easy to type on. Smaller laptops also have smaller displays, bringing us to our next subject.

Screen selection

Large laptops will have larger screens, but you may be surprised by what manufacturers pack into smaller laptops: a 14in screen with a 1,920 x 1,200 (16:10 aspect ratio) is pleasantly spacious. This also gives a slightly higher pixel density (denoted by pixels per inch, or ppi) than the more typical 1,920 x 1,080 resolution (16:9), which can make the difference between a screen appearing sharp or a fraction blurry at normal viewing distances.

While higher pixel densities are generally welcome for this reason, one of the reasons why this crop of laptops is more affordable is due to the price of panels with higher densities. Companies have to make sacrifices somewhere, and we would rather lose some ppi than suffer a drab panel with poor colour coverage.

We test all the laptop displays for quality, which are reflected in their gamut coverage (we print the results for sRGB and DCI-P3 colour spaces on p95), colour accuracy (measured by Delta E, the lower the better) and, to a lesser extent, contrast and brightness. While few of the laptops tested here pack top-quality screens, most remain pleasant to use for regular tasks. We mention those that are less pleasant to use in the reviews.

Touchscreens are useful but also one more thing to go wrong, so we consider them a nice-to-have rather than a must-have. Unless, that is, you want to take advantage of a convertible laptop, where the screen flips round to create a giant tablet (such as the HP Envy x360 13in).

ABOVE They may sound mundane, but a wide port selection makes your life easier

"Companies have to make sacrifices somewhere, and we would rather lose some ppi than suffer a drab panel with poor colour coverage"

BELOW Look for a 1080p webcam for high-quality video calls

What storage?

Many modern laptops come with 512GB SSDs, and that's usually ample for everyday use. While 256GB is now less common, it's fine if you don't intend to play the latest games or install Adobe's Creative Cloud apps and only want to store documents (as opposed to Netflix downloads and your own videos). Thankfully, for those people who need more storage, 1TB is often available as an upgrade option and most manufacturers won't charge you a fortune for the privilege.

Be connected

Your laptop must have what it needs to communicate with the internet, speakers and other connected devices. Wi-Fi 6E is slowly gaining ground in home and office networks, but Wi-Fi 6 remains the sweet spot for value and performance (avoid Wi-Fi 5 if you can, while Wi-Fi 7 is so new and expensive that it's not worth worrying about right now). If you want to be wired into your home router, you'll need an Ethernet port, but these are less common on slimmer and compact laptops.

Another wireless essential is Bluetooth. The latest consumer standard is Bluetooth 5.3, which is more reliable and quicker to react than Bluetooth 5.2, but the latter is still a solid choice at this price. Bluetooth 5.1 lacks things such as the LE Audio profile, which promises higher-quality audio streaming with less power drain, but don't dismiss a laptop just because it has Bluetooth 5.1.

USB ports are yet another area of differentiation. The gold standard are USB-C ports that support USB 4 and Thunderbolt 4, as these offer far higher transfer rates for data and for sending signals to attached screens. If you see USB-C 3.2 Gen 2, transfer rates drop to 10Gbits/sec, while USB-C 3.2 Gen 1 means 5Gbits/sec. You'll notice this when transferring lots of big files. You really want a laptop with at least two USB-C ports, as most laptops use these for charging.

USB-A ports remain useful for adding peripherals: keyboards, mice, microphones, printers. These support up to USB 3.2 Gen 2, but ye olde USB 2 ports remain (and are fine for mice and keyboards). Look out for USB-A ports that can keep charging devices when the laptop itself is switched off, as that can be surprisingly useful.

Finally, an HDMI connector will enable you to connect an external TV or monitor to your laptop. Look for HDMI 2.1 or HDMI 2, not 1.4, if you want smooth 60Hz viewing on an attached 4K display.

Better batteries

There are some truly excellent battery life scores on display in this month's Labs, and we print the full results on p95. For everyday use, anything above nine hours in the PCMark Modern Office test should keep you going for a working day. We test with the laptops in Balanced performance mode and with screens at a modest 150cd/m², so note that higher brightness levels, applying Performance settings or performing demanding tasks will all deplete your battery more quickly.

Can you hear me?

Webcam, microphone and speaker performance can't be taken for granted in a laptop. For video calls with friends, family or colleagues, high-quality video capture and sound will provide a far better experience for both you and your audience. For webcams, 720p is okay, but 1080p is a far better standard and these higher-quality cameras often capture colour and adjust to light better. A laptop's built-in microphone should offer clarity, minimise muffling and pick up your voice without major issues. Thankfully, most modern laptops perform well here.

Then we come to the speakers. You often find audio brands working with laptop manufacturers – and frequently with excellent results. However, it's no guarantee of top quality, and likewise we often find laptops with unbranded speakers that produce excellent results. Unfortunately, the only way to tell for sure is to read our reviews or head to a store and listen for yourself.

How we test

For testing this month's laptops we ran all models through PCMark 10, to highlight everyday capabilities across office, productivity and creative applications. We used Geekbench 6 to test pure CPU single-core, multicore and GPU compute performance, while CrystalDiskMark reflects the maximum achievable disk speeds for each laptop.

To test battery life we used PCMark's Modern Office, Idle and 1080p Video tests to get a full picture of expected uptime across use cases. For these tests, we set the machines to Balanced mode and the screen to 150cd/m².

We opted for 3DMark Time Spy and *Shadow of the Tomb Raider* for added gaming insights, and then ran each laptop through key browser-based benchmarks, providing an overview of speed and responsiveness.

You can see all the graphs on p94 and p95.

Acer Aspire 14

A real bargain for anyone who seeks after-hours gaming action in a relatively compact, affordable laptop

SCORE ★★★★★

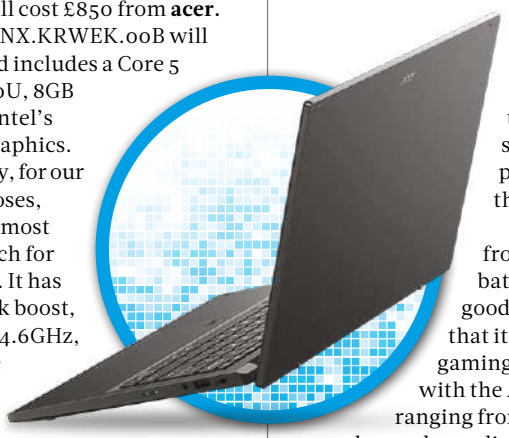
PRICE £708 (£850 inc VAT)
from acer.com

Acer's all-new Aspire 14 – distinguishable from the other laptops in its Aspire range through the A14-51GM that begins its model name – fits our "everyday" description perfectly. Although not as affordable as the Asus Vivobook or its Aspire Go 14 stablemate, the price is aggressive and it's based on the latest generation of Intel silicon, so you can expect years of strong performance.

We tested an early production unit fitted with a Core i5-1335U, together with 8GB of RAM and Nvidia's RTX 2050 graphics. The most similar model you can buy is the one with a part code of NX.KSVEK.005, which includes a Core 5 processor 120U, 16GB of RAM and the same graphics card. That will cost £850 from **acer.com**, but the NX.KRWEK.00B will cost £600 and includes a Core 5 processor 120U, 8GB of RAM and Intel's integrated graphics.

Thankfully, for our testing purposes, the 120U is almost an exact match for the i5-1335U. It has a higher clock boost, 5GHz versus 4.6GHz, and the same mix of cores: two performance P-cores, four efficiency E-cores. We would expect it crawl up one or two places in most of the non-gaming tests as a result (for example, it would almost certainly score above 8,000 in the Geekbench 6 multicore test).

The higher peak frequency would also help in games, but here it's the GeForce RTX 2050 graphics that really matter. The Aspire 14 scored a highly respectable 59fps in *Shadow of the Tomb Raider* at 1080p Low settings, even if the 4GB of RAM meant it didn't complete the same test at Highest settings. Perhaps the clearest mark of its talents came in 3DMark Time Spy, where it crushed all rivals with an integrated GPU, though it was humbled by the two true gaming laptops here, the HP Victus 15 and MSI Cyborg 15.



However, it's far lighter and sleeker than either of those machines.

Finished in a metallic silver, the Aspire isn't curved at its edges, but it doesn't feel angular, either. Ample ventilation neighbours four silicone feet on the underside, and opening the lid levers the base into a slightly elevated position at the rear.

Battery life from the 70Wh battery is pretty good considering that it has a discrete gaming chip inside, with the Aspire 14 ranging from seven to ten hours depending on usage. Those results place it in the middle of the pack for the laptops tested this month, and even though the 120U CPU is marginally more power-efficient than the i5-1335U we think our results are representative. The only real downside is that its 460g charger is one of the larger on test (but you can charge over USB-C).

The Aspire feels well built, and we experienced minimal flex in the base during use. Smart black keys support the black surround of the display, and although not the most stylish there's little to dislike. Typing feels natural and comfortable, even if the key actuation could be smoother, and although the touchpad is a modest 105 x 65mm it feels as accurate as any of the others here.

ABOVE Performance is above what you'd expect at this price

PC PRO LABS WINNER

LEFT The Aspire 14 is light, at 1.5kg, and slim, at just 18.9mm

BELOW The display isn't the best here, but it's fine for watching TV

Connectivity is good, too. The Aspire 14 comes with Wi-Fi 6E, and its ports feature one HDMI 2.1, one USB-C 4 (with Thunderbolt 4 support too), and two USB-A 3.2 Gen 1 ports. There's also a 3.5mm headphone jack, but no SD or microSD card slot.

The 1080p 60fps webcam is sharp and adjusts well in changing light, while the speakers provide good quality audio, even at peak volume. The mic captures voices clearly, with a little background bleed-in.

The display is perhaps the clearest indication of this laptop's budget. A non-touch 14in panel, with a bog standard 1080p resolution and 60Hz refresh rate, its 61% coverage of the sRGB colour space won't wow you with its colours. And its average Delta E of 3.69 means photographers shouldn't trust its accuracy. But let's not be too harsh: compared to some here colours look strong, brightness is fine at 289cd/m², and in everyday use you'll find this a clear and comfortable screen to use. Watching TV on the Aspire 14 is enjoyable, for example.

On balance, the Aspire 14 is a good option across everyday tasks: it's quick, comfortable to use, portable and not bad-looking, either. But it can also do more thanks to its discrete graphics – or you could save money and buy an option with integrated graphics.

Acer Aspire Go 14

It's tough to argue with this laptop's value for money or battery life, but speed lovers should look elsewhere

SCORE ★★★★☆

PRICE £375 (£450 inc VAT)
from acer.com

Acer's new Aspire Go 14 has clearly been designed to take the best elements from the Aspire 14 and place them into a more affordable and accessible model. Indeed, the similarities in style and design are so striking that it's tricky to tell them apart from a first look. The lighter metallic grey finish of the Go is the first clue, but it's specifications that really divide the two, justifying a clear price gap.

While the Aspire 14 range includes Intel's new range of chips – either the Core 5 processor 120U or the Core 7 processor 150U – the Go 14 will ship with either the Core i3-N305 or AMD's Ryzen 3 7320U. To confuse matters, Acer sent us an early sample with a Ryzen 5 7520U inside, but this specification won't be sold in the UK.

But no matter, as the 7520U is almost identical to the 7320U anyway. These are both four-core, eight-thread chips based on AMD's ageing Zen 2 architecture, and while the 7520U has a higher base and boost frequency (2.8GHz versus 2.4GHz, 4.3GHz versus 4.1GHz), you'll struggle to tell them apart in real-world use. Likewise Intel's N305 chip, which has eight single-threaded cores based on the aged (but still respectable) Alder Lake-N architecture.

Comparing performance to the Aspire 14 shows a clear difference in models, as the Go 14 finished last or near the bottom in CPU-focused and disk speed tasks even with the 7520U inside. That was to be expected, though, as on paper the Go 14's CPU is the least powerful here.

Still, this laptop is a solid performer for everyday tasks. If all you intend this laptop for is light office duties, then it will cope perfectly well. That's reflected in its PCMark Essentials and Productivity scores, where it competed gamely with more expensive rivals, and it was only in the tougher tasks – especially those that single out the CPU, such as Geekbench and Cinebench – that it struggled.

We suggest avoiding the cheapest, £380 Aspire Go 14, as this only includes 4GB of RAM and a 128GB SSD, while spending £450 doubles both the memory and storage to more suitable amounts. It isn't the fastest SSD, however, coming bottom in our tests with sequential reads and writes of around 1,750MB/sec.

Where the Go excelled was staying power. It showed strong battery life in all tests, clocking three minutes short of 15 hours on idle, and 11 hours in office tasks. At a similar weight to the Aspire 14, it's just as portable and feels as comfortable and as easy to use, although the Go's charger is around 170g lighter than its sibling's.

ABOVE The Aspire Go 14 is a sleek laptop for the price

LEFT The single USB-C port supports speeds of 10Gbits/sec

BELOW The keyboard is easy to type on

Acer's unfussy but neat styling works just as well on the Aspire Go as our Labs winner, with its black keys and bezel in place and matched by a black plastic underside. Keystrokes are smooth and stable, while the touchpad is more basic and best described as serviceable.

Some similarities continue to the display: the Aspire Go 14 also offers 61% sRGB coverage, although its peak brightness is 335cd/m² to the Aspire's 289cd/m². There's no perceivable difference in average Delta E scores, while the Go's contrast was the best on test at 1,588:1. For the price, this is a commendable display.

Acer does make some sacrifices in connectivity. You get Wi-Fi 6 rather than 6E, and the single USB-C port is stuck at 3.2 Gen 2 speeds of 10Gbits/sec. The two USB-A ports are slower still, being 3.2 Gen 1 ports (so 5Gbits/sec). You also benefit from an HDMI connector and a headphone jack.

Looked at as a pair of laptops, the Aspire Go 14 is a terrific alternative to the Aspire 14 if your budget doesn't stretch up to £600 for the cheapest version of that laptop. Its build and screen quality are both great for the price, while the 1.5kg weight and top-notch battery life mean it lives up to the "Go" in its name.

Asus Vivobook 15 (X1504)

A top-value laptop in terms of speed, and it includes some surprises, but the display lets it down badly

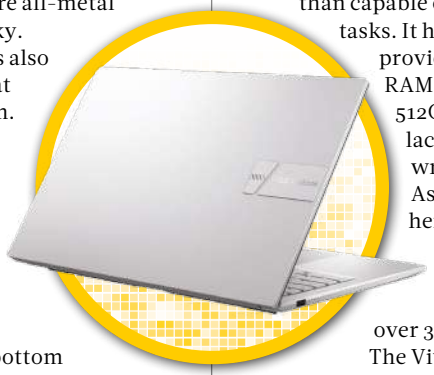
SCORE ★★★☆☆

PRICE £500 (£600 inc VAT)
from uk.store.asus.com

The Asus Vivobook is one of the more affordable laptops in this month's test, aiming to deliver the perfect balance of features, performance and value.

Although it photographs nicely, put away any premium expectations. While it looks great at first glance, with a metal finish on its top and keyboard surround, a closer look reveals that Acer has used plastic on the base and underside. That's to be expected at this price, but other laptops (such as the Aspire 14) don't pretend that they're all-metal – which is less tacky.

The Vivobook is also a sizeable laptop, at 360 x 233 x 17.9mm. Asus spreads the weight well, though, and even at 1.7kg we found it comfortable to carry. Still, a tiny 42Wh battery meant this laptop hovered near the bottom of our battery-life tests, so it's most at home on a desk, where the four corner silicone stand-offs keep it in place. It feels solid, too, as befitting a laptop tested in a selection of the US MIL-STD 810H military-grade standards for environmental stresses.



Asus adds no flourishes around the keyboard or touchpad, sticking to a plastic finish with the key. That stands in glaring opposition to their metallic surround. There's no backlight on the keyboard, either, meaning working in lower light isn't ideal.

That 360mm width gives Acer space to include a number pad, with shortening of keys limited to the left-side Ctrl and Shift. Typing on the keyboard is fairly comfortable with little movement in the base, although actuation feels abrupt and lacks some softness. That's at odds with our view of the touchpad which, while small at 107 x 73mm, responds well to gestures and is as smooth as you could ask for when working across office, web and creative applications.

Keep those expectations modest and it's a fine performer, too. True, with an Intel Core i5-1235U processor inside it never troubled the top of our performance tables, but it's more than capable of handling daily tasks. It helps that Asus provides 16GB of RAM, and while the 512GB SSD proved lacklustre for writes – even the Aspire 14 Go beat it here – few people can complain about sustained write speeds of over 3,000MB/sec.

The Vivobook 15 is another of this month's laptops to use Intel's Iris Xe graphics, and although it came bottom in the theoretical Geekbench GPU Compute tasks, an average of 23fps in *Shadow of the Tomb Raider* shows that Intel's chip has some gaming potential in lesser games.

ABOVE The Vivobook is a deceptively good-looking laptop

LEFT The single USB-C port supports 5Gbits/sec transfers

BELOW The keyboard has a number pad, but no backlight

Those results were at 1080p, which as it happens is the 15.6in panel's native resolution. And it's by far this laptop's weakest component. Turning on the laptop raised immediate questions about its quality, and our display tests provided explanations. Oddly, it looks its best when we pushed the screen flat using the 180° hinge, but at standard viewing angles the contrast and colours just feel off. It was no surprise to find that the laptop's sRGB coverage came in at a low 49%, which is below average, while our recorded contrast ratio was a poor 256:1. This is not a panel we would want to look at every day.

Connectivity options show similar signs of cost-cutting. The single USB-C port is stuck at 5Gbits/sec transfers (being rated USB 3.2 Gen 1), as are two of the three USB-A 3.2 ports – the third is lowly USB-A 2. We're less concerned by the HDMI port supporting the older 1.4 standard rather than 2.1, meaning an attached 4K display would be limited to 30Hz.

We were, however, impressed to see Wi-Fi 6E on-board. And by the Vivobook's SonicMaster speakers, which offer clarity and excellent balance across music and video audio. That's not matched by the microphone, which offered some echoey acoustics, while the 720p webcam (which usefully has a privacy cover) was fine with details but displays washed-out colours, and thrown off by changes in lighting.

While benchmarks proved this is a good performer across both office and CPU workloads – a Core i7/1TB version is available for only £50 more – if you have around £600 to spend then we suggest you take a look at one of the cheaper models in Acer's new Aspire 14 range. Your eyes will thank you.

HP Envy x360 13in

A 12th generation Core chip helps keep the price of this flexible and high-quality convertible down

SCORE ★★★★☆

PRICE £833 (£1,000 inc VAT)

from hp.com/uk

This is the most physically flexible laptop in this test; if you need an everyday option that can double up as a tablet, then the HP Envy x360 may be for you. This robust laptop feels mighty despite its size, making it a natural alternative to the MSI Prestige 13 Evo.

Let's start with the similarities. It may not include "Evo" in its name, but the Envy x360 also makes use of Intel's platform. So, you again benefit from Intel's promises for excellent battery life, snappy wake-up times from sleep and nippy performance in a compact laptop.

The Envy delivers in all areas, but here you must make do with a 12th, not 13th, generation Intel processor: the Core i7-1250U. The Envy's processor is not only older but also features a power-efficient "U" coded CPU, while the MSI has a "P" chip. The main difference is that the P chips have four performance P-cores while the U alternative makes do with two, and that's the key reason why the MSI takes such a clear lead in the multicore sections of tests such as Geekbench and Cinebench. But this is far from a slow laptop; it will just take that much longer to complete tasks that activate many cores at the same time.

More importantly for the highly mobile audience this laptop is aimed at, it packs top-tier battery performance. The Envy x360 lasted over 19 hours in our idle test and 15 hours when playing back 1080p video. In light office use, the laptop lasted one minute short of 15 hours, so longevity is guaranteed. Only the MSI Prestige 13 Evo came anywhere close to challenging the HP's supremacy.

Those seeking a gaming laptop will inevitably be disappointed by Intel's Iris Xe graphics, but as the *Shadow of the Tomb Raider* results show – with mid-20fps rates for both laptops – there's some after-hours potential here so long as you don't mind playing older, less demanding games.

Intel's Evo platform extends to the promise of a sleek design, which the Envy x360 certainly is at 16mm slim, and it feels robust, too. Its construction features recycled aluminium and sustainable materials such as ocean-bound plastic (though we apply our usual caveats about this, as the "ocean" extends 50km inland in ocean-bound plastic's official definition), while a premium sandblasted and anodised finish gives it a smart and stylish feel.

ABOVE The HP Envy x360 is a sleek, robust laptop

Oddly, this laptop is tricky to open from flat: the coming together of curved edges requires a pause for focus. We found it easiest to put it into a vertical position with the hinges against our lap. Still, the 360° geared hinges feel secure.

Once open, the compact keyboard is easy to use, with a comfortable key action giving us no concerns about overly soft or stiff actuation. Further south, the HP's touchpad is responsive, as is the stylus-supporting touchscreen.

LEFT The recycled aluminium finish gives the Envy x360 a smart and stylish feel

BELOW Tablet mode adds to this laptop's versatility

We must also commend HP on the Envy x360's connectivity. You get two USB-C 4/Thunderbolt 4 ports, one of which is required for charging the laptop, as no AC charge option is available. HP also includes two USB-A 3.2 Gen 1 (5Gbits/sec) ports, with hinges on the bottom casing of those ports allowing the laptop's outer edge to maintain its slim lines when the ports aren't in use. It's a style-conscious choice, but this fits the laptop's aesthetic. Wi-Fi 6E and Bluetooth 5.3 are both present, as is a microSD card slot, but unlike MSI's laptop there's no HDMI port here.

HP hopes to add to its style points by including Bang & Olufsen-branded speakers. These work their magic right up to 100% volume, across genres and media types, delivering sound so enjoyable we were happy to keep listening. A real bonus if you don't want to use headphones and like to watch movies and TV shows, or listen to music at full blast. This excellent audio matches a fine display, offering the brightest reading on test of 476cd/m² and sRGB coverage of 98%. With an average Delta E reading of 0.38, the second best result this month, it adds up to a top-quality and vivid 13.3in display. A 1,920 x 1,200 resolution means it looks sharp, too.

All of this means that if you have £1,000 to spend on a stylish ultraportable with great battery life, then you have a straight choice between the faster MSI Prestige 13 Pro and the more flexible HP Envy x360 13in. Both are superb choices.

HP Victus 15

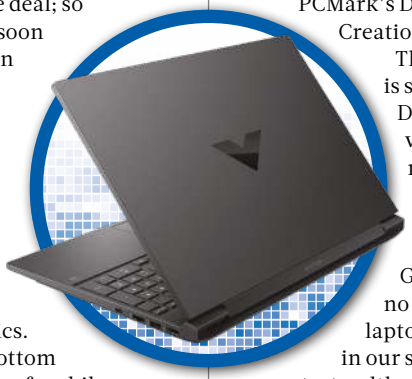
A direct competitor to the MSI Cyborg, the Victus wins out for overall quality but not for speed – or availability

SCORE ★★★☆☆

PRICE £750 (£900 inc VAT)
from johnlewis.com

Gaming laptops can be considered everyday devices in the same way that 4x4 vehicles are everyday cars. They consume far more power to perform any given task, are much larger, and all that extra power is only fully utilised by a subsection of owners. Nonetheless, the HP Victus 15 is one laptop with gaming credentials that doubles up as a handy everyday workhorse – and unlike so many gaming laptops, it's affordable.

How affordable depends on what deals HP is running. In our testing period, from mid-May to early June, it was selling this model of the Victus 15 (identified either by its full name of Victus Gaming Laptop 15-fb0003na or the part code 6P128EA#ABU) for £699. Considering what you're getting, that's a remarkable deal; so remarkable that it soon went out of stock. In fact, the only place we could find it for sale was at John Lewis for a far less exceptional £900.



Its most important component is Nvidia's GeForce RTX 3050 Ti graphics. This sits near the bottom of Nvidia's 30 series of mobile chips, so don't expect wild frame rates, but a return of 76fps in *Shadow of the Tomb Raider* at 1080p Highest settings is hard to argue with. Only two other laptops here include discrete graphics: the Acer Aspire 15 comes with an RTX 2050 chip, the MSI Cyborg 15 with Nvidia's demonstrably superior RTX 4060 graphics – and they all wipe the floor with their rivals.

This table-topping form doesn't carry over to everyday tasks that rely on the CPU, with the Victus including AMD's long-in-the-tooth Ryzen 7 5800H processor. Still, it's no slouch. Released over three years ago, the 5800H is based on AMD's Zen 3 architecture and includes eight performance cores to give you 16 threads. It came near the bottom of the single-core tests in Geekbench 6 and Cinebench R23, but excelled in the latter's multicore tests. Boosted by the discrete graphics, it performed well in PCMark's Digital Content Creation section, too.

The 8GB of memory is split over two 4GB DIMMs, both of which are replaceable. As is the 512GB SSD, but the Victus only supports Gen 3 speeds; it was no surprise to see this laptop near the bottom in our sequential read tests, although it performed better when writing.

The Victus 15 has an understated design for a gaming laptop, with a brushed matte grey finish and not even a hint of sRGB excitement. It offers only one USB-C port, which shares the same slow USB 3.2 Gen 1 speeds as the pair of USB-A ports. But HP does include a hinged Ethernet port, HDMI 2.1 connector and a full-size SD card slot. It's Wi-Fi 6 rather than 6E, but that's a respectable amount of connectivity.

A quick look at the underside and the rear reveals air vents for heat dissipation, while the heft of this 2.3kg device is obvious the moment you lift it from the box. It's not that wide – narrower than the Asus Vivobook – but its 358 x 255 x 23mm dimensions mark it out as a laptop for tables rather than laps. Still, battery life isn't awful: seven hours in our video-rundown test.

ABOVE The Victus 15 has an understated design for a gaming laptop

LEFT Air vents at the back and underneath aid heat dissipation

BELOW A pixel density of 141ppi means text can look fuzzy

That was at the 15.6in panel's native 1,920 x 1,080 resolution, and the screen is not this laptop's finest feature. It's fine for games, helped by rapid 144Hz refresh rates, but if you intend to work on this laptop then you may find the 141ppi pixel density results in fuzzy-looking text. Nor is it great for colour coverage or accuracy, reproducing 58% of the sRGB gamut with an average Delta E of 4.44.

You can buy a more balanced all-rounder for another £100 in the MateBook D16, while the MSI Cyborg 16 is more powerful. But the Victus has a nicely tactile keyboard, a large and smooth touchpad, high-quality B&O speakers and a mic and webcam that, while not perfect, are both very usable.

If your everyday needs include gaming, this is a more refined option than the MSI Cyborg 15. And if it ever comes back on sale for £699, snap it up.

Huawei MateBook D16

The best and biggest screen here, plus a powerful Core i9 processor, ensure the MateBook D16 stands out

SCORE ★★★★☆

PRICE £833 (£1,000 inc VAT)
from huawei.com

The MateBook D16 is larger than any of its rivals this month, with a 16in display its most dominant feature. And don't think this laptop is an immovable feast: at 1.7kg, the D16 is a great option for those who like to work and play in different areas of the house rather than sitting at a desk all day.

A £1,000 price is similarly sizeable in this month's company, but that's because its size comes with power attached. Intel's 13th generation Core i9-13900H is the most powerful processor in this Labs by a distance, and Huawei pairs it with a 1TB SSD drive and 16GB of memory.

There's little that stands out style-wise, but the D16 looks smart with its all-metal, grey, aluminium design. Despite its large 357 x 249 footprint, it's slender at 17mm tall and shouldn't weigh you down too much with a 1.7kg weight. Its charger is only 200g, too, so for overnight trips it adds up to a surprisingly portable design. It feels comfortable on a lap, too.

A smooth opening action reveals a full keyboard complete with number pad. Huawei shrinks the Shift and Ctrl keys, but otherwise makes no space sacrifices, and those with larger hands will appreciate the amount of space for rested palms. In terms of action, it can't match the Lenovo ThinkPad – the key actuation is too severe for our tastes – but it's still pleasant to type on. The touchpad is responsive, too: not once did it fail to detect our intended gesture.

As a larger laptop, there is plenty of space around the chassis for Huawei to add ports. So we were disappointed that the MateBook D16 offers a single USB-C port – for charging, data transfers at a lowly 5Gbits/sec or monitor output – alongside two USB-A ports. And one of these is rated as USB 2, so is only useful for undemanding devices such as mice. There's a single HDMI 1.4 port and a 3.5mm jack, but no SD or microSD card slot. There's no AC charging port, either, so that lonely USB-C port is required for charging. This meagre wired assortment is matched by this laptop's wireless support, which is limited to Bluetooth 5.1 and Wi-Fi 6.

Fortunately, there are other elements where Huawei has been more generous. In particular, the 1,920 x 1,200 16in display achieves a strong 97% sRGB coverage with an average Delta E of 0.37. Colours look excellent, and while its maximum brightness of 329cd/m² sits around the middle of this month's laptops, that's plenty for indoor use. The only downside of Huawei's choice is sharpness, with a 141ppi density inevitably leading to fuzziness around text.

The MateBook's speakers are more average than the screen: they sound solid at lower volumes, but ramping up the levels exposes a lack of low-end and a mix of high and mid-tones.

The MateBook's 720p webcam feels equally underpowered, struggling to offer clarity, especially with movement – not ideal if you regularly make video calls. The onboard microphone is solid, though, capturing clear audio without issue.

ABOVE A top-quality 16in panel and Core i9 are this laptop's stars

PC PRO RECOMMENDED

LEFT Not gorgeous, but a sleek design adds professionalism

BELOW Huawei packs a number pad in, as it should at this width

As expected, performance is where Huawei races ahead . Undoubtedly this is where the main investment has been made. The MateBook claimed first place in all non-GPU benchmarks, including Cinebench rendering, only losing out in the GPU-focused PCMark 10 content creation and the combined PCMark 10 overall test. It blitzed our single- and multicore CPU tests, while the Core i9 gave Intel's integrated Iris Xe graphics a clear boost. It scored well in 3DMark Time Spy and even broke 40fps at 1080p Ultra in *Shadow of the Tomb Raider*, so there is the option for after-hours gaming so long as you don't want to play the very latest games. For that, you'll need to buy the HP Victus or MSI Cyborg.

Outright non-gaming performance and an excellent display are key to this laptop, but it delivered strongly across our battery tests, too: each hit over ten hours, even surpassing 13 hours in the video-rundown test.

If you don't need this much power or such a large screen, then you have plenty more portable options elsewhere. The Samsung Galaxy Book4 offers superior styling, for instance, while the Acer Aspire 14 has the attraction of even faster graphics in a lighter and more compact chassis. But if your everyday needs involve bags of power, a huge screen and solid battery life, the Huawei MateBook D16 is the laptop to pick.

Lenovo ThinkPad E16 Gen 1 (AMD)

By no means the last word in excitement, but the ThinkPad E16 is a good-value choice for business users

SCORE ★★★★☆

PRICE £696 (£835 inc VAT)
from lenovo.com

Buy a ThinkPad and you know you're buying a trustworthy and reliable machine for day-to-day work – and make no mistake, this is an all-out business laptop. This is the first-generation ThinkPad E16, available with AMD or Intel chips, and is currently something of a bargain as Lenovo is slowly bringing Gen 2 models to the market.

Lenovo's E series of ThinkPads are designed for affordability, but despite this it looks and feels like almost every ThinkPad you can imagine. It comes, as usual, with a completely matt black style that isn't for everyone but does make an immediate statement of corporate intent. The chassis is aluminium aside from the plastic bottom, and it feels reassuringly solid. It comes with one year of Lenovo's Premier Support cover, complete with next-business-day repair.

You can expect speedy performance, too. Our review sample included the AMD Ryzen 5 7530U, which it no longer ships with, so the price above includes the closest offering: a 7430U. This has a lower peak frequency, 4.3GHz to 4.5GHz, but with the same six cores and 12 threads you can expect similar speeds as in our tests. Those who need more should spend an extra £80 on the Ryzen 7 7730U, as this gives you eight cores and 16 threads.

Our tested system included 16GB of RAM, but the price includes 24GB: 16GB soldered, 8GB via a SODIMM. If you need even more, you can choose the 72GB model (40GB/32GB) as that only costs an extra £35 at the time of configuration. Less impressive are AMD's integrated AMD Radeon graphics, especially compared to the discrete graphics seen elsewhere.

In terms of results in our tests, "solid" is the word. The Ryzen 5 and AMD graphics pairing doesn't match up well to Intel's 12th or 13th Gen processors and Intel Iris Xe graphics, as a glance at the graphs on p94 makes clear. Still, it won't slow you down in office tasks, and that's reflected in its fourth place in the PCMark Essentials benchmark and second position in the Productivity test. It's content creation – or any task that requires heavy work across multiple cores – where this laptop falls down.

Notably, any tests that focused on the graphics chip also dragged it down the table. When it comes to gaming, think light. The E16 came second from last in 3DMark's Time Spy DirectX 12 benchmark, and couldn't even hit double digits for frames with low settings in the *Shadow of the Tomb Raider* benchmark. Its battery-life tests were slightly better, typically lasting around seven hours, but at 1.8kg this chunky laptop isn't designed for life on the move.

Slap it on a desk, though, and the ThinkPad E16 is the epitome of strong, function-focused design. A square lid covers an expansive keyboard, complete with number pad and minimal key shrinkage – there are even separate arrow and PgUp/PgDn keys. The keys don't have the cushioning of more expensive ThinkPads, with a relatively snappy 1.5mm travel, but they're clearly designed for heavy use over the lifetime of the laptop and feel solid. As ever, Lenovo's TrackPoint cursor controller sits above the touchpad, and thanks to a pair of buttons it's fairly intuitive even for new users.

ABOVE **The ThinkPad brand guarantees business-like reliability**

LEFT **At 1.8kg this chunky laptop isn't designed for life on the move**

BELOW **A number pad adds to the laptop's functionality**

The ThinkPad's webcam is clear if a little lacking in saturation, and its speakers are what you'd expect from a business laptop: fine for video calls, but they miss some low-end so headphones or external speakers are the best bet for anyone wanting to enjoy music or films with deeper audio. The microphone records clear audio, with our recorded test delivered back to us in a voice that was wholly familiar, without distortion or a skewed pitch.

One area where the budget shows itself is the screen. sRGB coverage was joint lowest at 54%, while its average Delta E of 4.79 again pushed it close to the bottom of the table. This is not a laptop for photographers. However, its anti-glare covering ensures it's always visible, especially when paired with a peak brightness of 348cd/m² and solid 1,159:1 contrast ratio. You might notice slightly fuzziness on text, with a 1,920 x 1,200 resolution across a 16in display equating to 141ppi, but at least there's plenty of room; viewing two windows side by side is bearable.

Ultimately, a business-focused laptop is best for business-focused tasks. That rings true for this ThinkPad, which is comfortable dealing with apps, office work and most multitasking outside of content creation. If you want to break out of pure office gridlines, this isn't the laptop to opt for, but if you're looking for a largely desk-based workhorse backed with a great warranty then it's a strong choice.

The Chromebook alternative: Lenovo IdeaPad Flex 5i (Gen 7)

If you're looking for an everyday laptop and aren't locked into Windows, then Chromebooks such as the Lenovo IdeaPad Flex 5i are a great alternative

SCORE ★★★★☆

PRICE £416 (£499 inc VAT)
from lenovo.com/uk

BELOW The IdeaPad Flex 5i is a great-value Windows alternative

One of the many things we like about Chromebooks is their worry-free nature. With Windows, you have to mess around with settings to maximise battery life, ensure updates install smoothly and generally fuss about. Google's Chrome OS offers a simplified approach to everyday computing, with everything connected, clean and synchronised. While you can download files for offline use, it works best for those who are always online –and a laptop such as the Lenovo IdeaPad Flex 5i could also be more cost-effective than a Windows laptop.

This IdeaPad is a well-put-together touchscreen Chromebook with 360° hinges and stylus support. As such, it's a flexible alternative to the traditional laptop Windows format, opening up extra opportunities for use. Especially as you can download apps (albeit only compatible ones) from the Google Play store.

LEFT The touchscreen, 360° hinges and stylus support give flexibility

For the price, this is a well featured laptop. Its 1080p 14in display is bright, peaking at around 300cd/m², while a glossy finish adds extra punch to colours. Those seeking 100% of the sRGB should look elsewhere – it's closer to 65% – but in isolation it looks good.

Lenovo includes a sharp and useful Full HD webcam for video calls, while its speakers are high quality enough to hear friends or family clearly. Or just to enjoy YouTube, streaming services and online games. Music lovers might call upon the headphone/mic combo jack, which sits alongside a microSD card slot, a single powered USB-A port and two USB-C ports. These both support 10Gbits/sec transfers and can be used to output to a monitor and charge the device. There are also handy up and down volume buttons on its right edge, and it's great to see both Wi-Fi 6E and Bluetooth 5.3 at this price.

A blue-grey metallic finish means this Chromebook looks and feels like it's worth more than its £500 price suggests. However, it's no ultraportable. It's surprisingly thick at 19.8mm and it weighs 1.6kg, so don't imagine it's going to replace your iPad.

BELOW The keyboard is comfortable to type on, but not up to ThinkPad standards

A solid construction provides consolation for those bulky dimensions, but frequent travellers may grow frustrated with its battery life. It lasted for around eight hours when playing back a video, so not great; fortunately the 45W power supply isn't too big or heavy.

On a Windows laptop, we would be nervous about having an Intel Core i3-1215U inside. This is a six-core, eight-thread power-efficient processor, and it's perfect for Chrome OS workloads. In fact, we'd call the Flex 5i "snappy". It's supported by a 256GB Gen 4 SSD, which is ample for apps and any files not stored in the cloud, while 8GB of RAM is plenty to keep things running smoothly. Less great: that memory is soldered onto the motherboard.

Lenovo doesn't pay as much attention to the keyboards in its IdeaPad range, and that's true here, but it's still comfortable for all-day use. The trackpad is a good size, and don't forget you can navigate using the touchscreen, too.

To see the full range of Chromebook options, we suggest you check out our Labs from three months ago (*see issue 356, p76*). The £799 Acer Chromebook Spin 714 came top there, and the extra money buys you a superior 14in screen, better ports and a Core i5 processor. However, we can't argue with the IdeaPad's value. If you don't necessarily want a Windows machine, and spend much of your time browsing the internet and working and playing online, the Flex 5i is an excellent alternative.

SPECIFICATIONS

6-core (2 P-cores, 4 E-cores) Intel Core i3-1215U processor • Intel UHD Graphics • 8GB LPDDRx-4266 RAM • 14in 60Hz IPS touch panel, 1,920 x 1,200 resolution • 256GB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p webcam • 2 x USB-C 3.2 Gen 2 • USB-A 3.2 Gen 1 • microSD card slot • 3.5mm combo jack • 51Wh battery • Chrome OS • 316 x 229 x 19.8mm (WDH) • 1.6kg • 1yr C&R warranty • part code 82T5001PUK

MSI Cyborg 15 A12VF

RTX 4060 graphics makes this the fastest gaming machine by a distance, but there are sacrifices

SCORE ★★★★☆

PRICE £741 (£889 inc VAT)
from very.co.uk

MSI's Cyborg 15 has direct competition in this Labs: the HP Victus 15. But for gamers who seek high frame rates beyond anything else, it holds the ace card in the form of Nvidia's RTX 4060 GPU. Turn to our graphs on p94 and you'll see the MSI was the clear winner in all of our gaming tests, with its most notable results being 7,635 in 3DMark's Time Spy DirectX 12 and 103fps in *Shadow of the Tomb Raider* at 1080p and Highest settings.

Like HP, MSI saves money by choosing an older processor. Here, it opts for Intel rather than AMD, with the Core i7-12650H now two generations old, having been launched in 2022. The "H" in the chip's name denotes Intel's high-performance chips, which demand lots of power (45W) but in return provide excellent peak frame rates and plenty of performance P-cores. Here, six P-cores can reach 4.7GHz, while four efficient E-cores handle background tasks.

With 16GB of RAM (split across two replaceable DIMMs with support for up to 64GB) versus the Victus' 8GB, the MSI was faster than its HP rival in almost every speed test. Both laptops enjoy more challenging tasks, so if you're looking for a system to tackle video edits or crunch code then they'll excel. Sadly, the 512GB SSD isn't the largest or fastest here, and despite the size of the chassis there's no second M.2 slot.

And this is a big laptop. At 2kg it's a shade lighter than the HP Victus 15, but isn't a laptop designed for regular travellers. Just to hammer that point home, it came bottom in all of our battery rundown tests, struggling to last much more than three hours under light use. And that's with the screen set to a modest 150cd/m².

If you do carry this laptop with you, don't expect many compliments on its design. The casing mixes a matte grey finish on the top and keyboard surround with highly stylised lettering on the keyboard, with translucent material on the WASD keys and the power button. This translucent design carries on to the underside and the hinges, so let's just say that it won't be to everyone's taste.

Build quality is good, though, and in MSI's defence what matters most to gamers is cooling. That's why vents are such a dominant part of this laptop's design, and they clearly do their job.

ABOVE The Cyborg 15 is built with fast frame rates in mind

LEFT The three USB ports are all of the lowly 3.2 Gen 1 type

BELOW The design is likely to split opinion

MSI squeezes in a compact number pad but, unusually, doesn't shift the trackpad to the left; when you're typing, this means it sits ever so slightly more to the right than you expect. Thankfully, it's quite wide. The typing action is pleasant, so even though we noticed some button shrinkage, generally this is a decent keyboard to work and play on.

We find it tougher to pick out highlights for the 15.6in 1080p display. In games, it's fine, helped along by a 144Hz refresh rate (like the Victus). However, 43% sRGB coverage, an average Delta E of 3.91 and 275cd/m² peak brightness are low figures. It's viewable, sure, but not superior.

Again mirroring the HP Victus, MSI provides one USB-C port and two USB-A ports, all locked to the lowly 3.2 Gen 1 standard; don't expect high transfer rates if you attach an external disk. Again, Wi-Fi 6 is kept company by an always welcome physical Ethernet socket, while HDMI 2.1 support means you can output to a 4K screen at 120Hz or a 1440p monitor at 240Hz.

It's not worth spending much time on the 720p webcam other than to say it's there and needs plenty of light to produce okay results. Those hoping for face recognition or a fingerprint sensor can keep on hoping. At least the speakers provide decent results, unless you're a bass lover.

With a street price of under £900, the MSI Cyborg 15 delivers on its core promise: speed. It may lack the refinement of the HP Victus 15, but if frame rates are your top priority then it's a great-value choice.

MSI Prestige 13 Evo

A superb advert for Intel's Evo marketing, this is a powerful and super-light laptop that's worth its price

SCORE ★★★★½

PRICE £833 (£999 inc VAT)
from currys.co.uk

MSI's Prestige 13 Evo is a diminutive and premium laptop, and while it's among the most expensive here it offers remarkable value compared to other sub-1kg laptops (it's 990g to be precise). For not only does it offer elite performance and ultraportability, it also scores clear style points. We're sure Intel will be pleased, for not only does it tick all the right boxes to qualify for its Evo marketing but MSI even puts Evo into the name.

The basic promise of "Intel Evo" is that you get fast performance, near-instant wake-ups from sleep and a full working day of battery life. Taking the latter first, the Prestige 13 Evo delivers with superb results of 18hrs 4mins when idling and 12hrs 27mins in PCMark's light-use Modern Office test. Only the HP Envy x360 fared better. It also reached 39% of capacity in only 30 minutes of charging, hitting full in under 90 minutes.

Whether you log in using the webcam or fingerprint reader, Windows 11 will appear within a trice, as promised. And it is indeed speedy. Intel's Core i7-1360P may be a year old now but it remains a superb performer, with four P-cores and 8 E-cores giving you a total of 16 threads to throw at tasks. Turn to our graphs on p94 and you'll see it near the top in all areas other than gaming. MSI gives it extra help courtesy of 16GB of RAM and the fastest SSD on test. It's a 1TB unit, too, so hopefully you won't run out of storage space.

The Prestige 13 Evo's premium feel starts with its casing, fashioned from a lightweight magnesium aluminium alloy. While lightweight enough to almost forget once in a bag, the MSI feels sturdy, with little flex in its base.

Once the laptop is open, the screen casing usefully levers the keyboard to a higher angle from the rear. This is a nice ergonomic feature, although the base of the screen and two small stand-offs apply slight pressure to the surface below – be that surface a table or your thighs.

Those with larger-than-average hands may also not love the compact, 75% keyboard. But that's an inevitable compromise when a laptop measures 299mm wide, and while there are signs of squeeze – note the half-height cursor keys, with Page Up and Page Down right next door – when typing all the keys feel responsive and satisfyingly tactile. We even liked the short, snap-to-it actuation of the keys. The touchpad is smooth with little resistance, and is equally responsive across single and multitouch use.

Connectivity-wise, it's tricky to fit much into such a compact design, but MSI does well overall. It offers two USB-C 4/Thunderbolt 4 ports, which double up as charging ports for the laptop and can support super-fast data transfer and external displays. More surprisingly, there's an HDMI 2.1 connector that can output to a 4K monitor at 60Hz. The single USB-A port supports USB 3.2 Gen 1 (so 5Gbits/sec), while a further AC port is there for charging the device, along with a microSD card slot. You even get Wi-Fi 6E and Bluetooth 5.3.

ABOVE This is a laptop that offers speedy performance in an ultraportable design

PC PRO RECOMMENDED

LEFT The Prestige lives up to its name with its lightweight aluminium casing

BELOW The compact keyboard has tactile and responsive keys

Yet another major positive is the screen. A 16:9 display using 90% of available space, its 1,920 x 1,200 resolution looks sharp across a 13.3in diagonal. Of course, you might hope for more than 60Hz refresh rates and a higher resolution still, but again we draw your attention to this ultraportable's price.

More to the point, this is a high-quality display that shone in our tests. Its peak brightness of 457cd/m² is the second highest on test behind the HP Envy x360, it covered a commendable 94% of the sRGB colour space, and an average Delta E score of 0.73 reflects its excellent colour accuracy. It's a vibrant and bright display we'd be happy to stare at for hours.

Less convincing are the laptop's speakers. These are clear in mid to high-end tones, but lack low-end coverage and sound tinny. We dared only briefly to hit maximum volume and could feel the laptop vibrate even before reaching 50%. These speakers, alongside a fair microphone and sharp and bright 1080p webcam (with shutter), are better suited to video calls than music or films.

It all adds up to a superb laptop that more than delivers on Intel's Evo branding. It handles single- and multicore workloads admirably – and all in a small, premium package.

Samsung Galaxy Book4

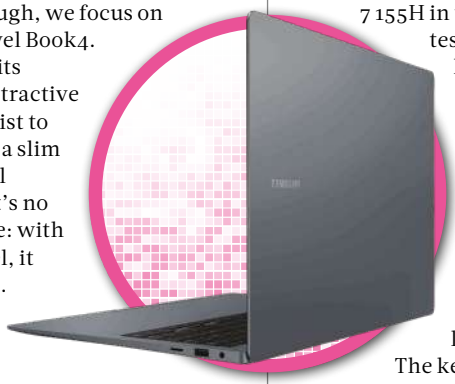
The cheapest Samsung Galaxy laptop has a poor display, but elsewhere it's hard to criticise

SCORE ★★★★☆

PRICE £790 (£949 inc VAT)
from samsung.com

Samsung's stylish approach to technology is exemplified by its Galaxy Book range. These premium laptops look and feel exactly as you would expect for their price, with the £949 Book4 the cheapest laptop in the range. We've already reviewed the £1,699 Book4 Pro 16in (*see issue 355, p64*), and that price is made to look modest compared to the top-end Book4 Ultra at £3,549. Nor does the range end there. You can also choose "360" versions and pick between 14in and 16in editions, while Samsung has just added the Copilot+ Book4 Edge (starting at £1,399).

Here, though, we focus on the entry-level Book4. This, like all its siblings, is attractive and minimalist to look at, with a slim and all-metal design, but it's no ultraportable: with a 15.6in panel, it weighs 1.6kg. It's easy to carry around, though, and you probably won't need to take the super-light USB-C charger with you as it lasted around ten hours in our light-use battery tests.



Our review sample included an Intel Core 7 processor 150U, 8GB of RAM and a 512GB SSD. If you're willing to make do with a 256GB SSD then the price drops to £649, while the CPU downgrades to a Core 3 processor 100U. We far prefer the 150U, as it includes two of Intel's most recent 5.4GHz P-cores and eight E-cores for a total of 12 threads. The 100U drops down to four E-cores, and its P-cores' peak frequency is a more lowly 4.7GHz.

Our benchmarks soon showed how powerful the supplied specification was. The Book4 excelled in CPU-focused workloads, sitting near the front of the pack in single- and multicore processor benchmarks. It was only held back in wider tests by a weaker GPU performance than, say, the Huawei MateBook D16 and Acer Aspire 14. While the Core 7 Ultra 7 155H in the Book4 Ultra we tested is faster still – helped along by six P-cores and two extra low-power efficiency cores – we think most people will be delighted with the power on offer here.

Likewise the laptop as a whole. The keyboard is usable for long periods, assuming you don't mind the modern-style short travel distance, as with a satisfyingly tactile feel. Nor was there any noticeable bounce in the base. The trackpad loses the glass-coating of its more expensive siblings, but the speakers, webcam and microphone all deliver respectable quality.

ABOVE The Book4 is a fine choice but its display lets it down

LEFT The laptop is well designed and has a good selection of ports

BELOW The keyboard is usable for long periods, despite the keys' short travel

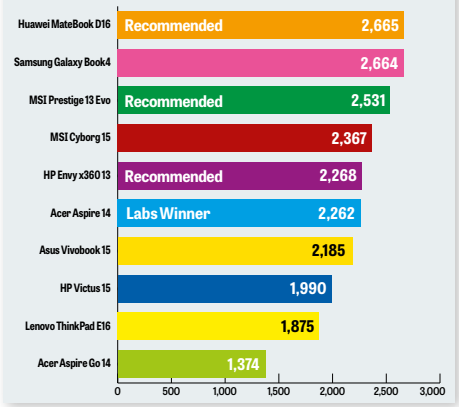
At first glance, Samsung doesn't skimp on the wired connectivity. The Book4 offers two USB-C ports, but don't expect Thunderbolt 4 or USB 4 speeds, with Samsung opting for USB 3.2 Gen 1 and thus 5Gbits/sec bandwidth. You also get two USB-A Gen 3.2 Gen 1 ports, a microSD reader, 3.5mm audio jack and an Ethernet port. Samsung skimps on wireless connectivity by opting for Wi-Fi 6 rather than 6E. You can upgrade this yourself, though, and even more surprisingly there's a second M.2 slot for storage expansion.

All of which is good – but then we come to the screen. This 1080p 15.6in display is bright enough for indoor use, peaking at 309cd/m², but its 910:1 contrast ratio is lower than the 1,000:1 we'd like. And its sRGB coverage is frankly pathetic at 54%. We weren't surprised to see the Book4 come bottom in our colour accuracy tests with an average Delta E of 5.45.

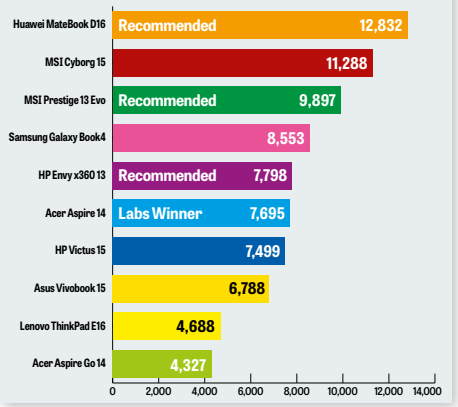
The Galaxy Book4 is in many ways a high-quality offering, but we can't recommend a laptop that costs almost £1,000 when it includes a screen this poor. Even if you choose the £649 edition, you can do better by choosing one of the Book4's many rivals this month. The Labs-winning Acer Aspire 14 may not look as attractive, for example, but it's a much better all-rounder – and, like the Book4, it comes in a variety of specifications to match your budget.

Speed tests

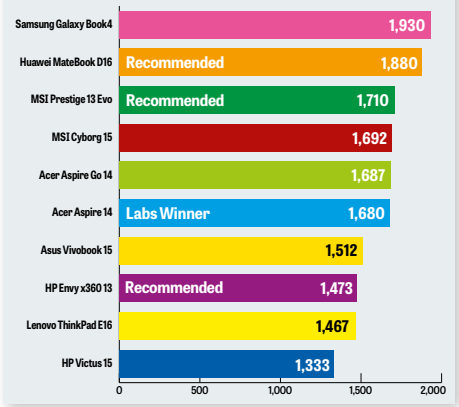
Geekbench 6 single-core



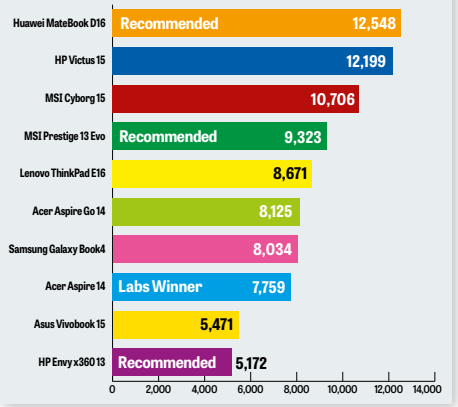
Geekbench 6 multicore



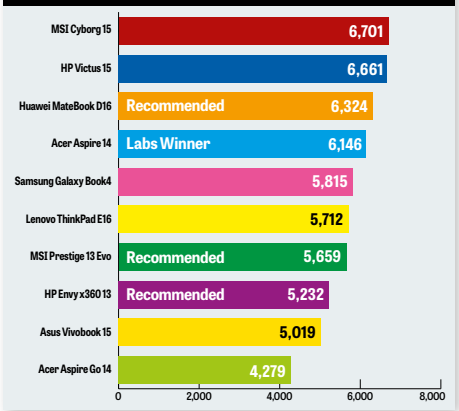
Cinebench R23 single-core



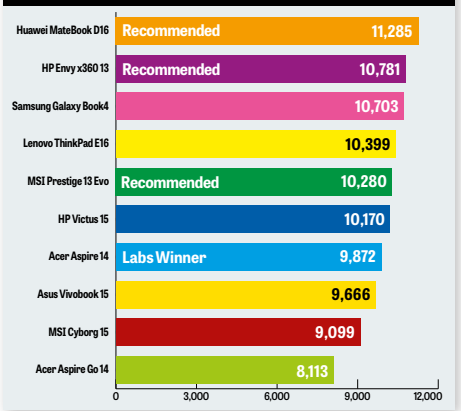
Cinebench R23 multicore



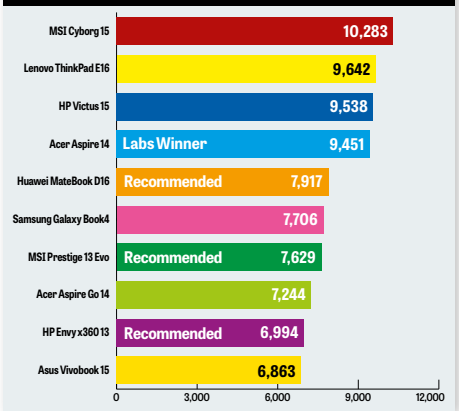
PCMark 10 overall



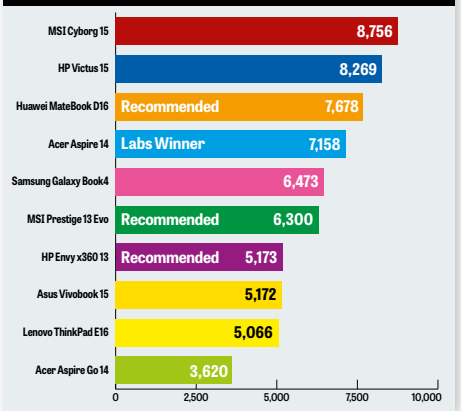
PCMark 10 Essentials



PCMark 10 Productivity

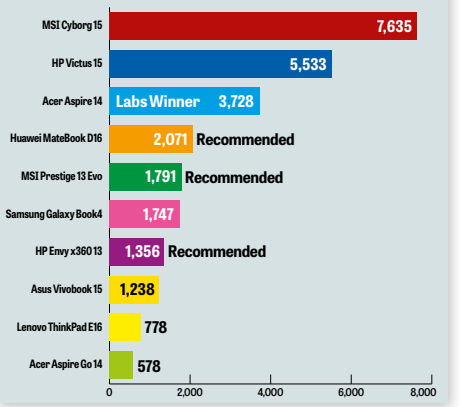


PCMark 10 Content Creation

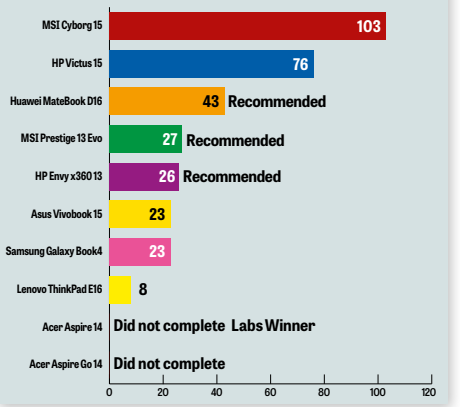


Gaming tests

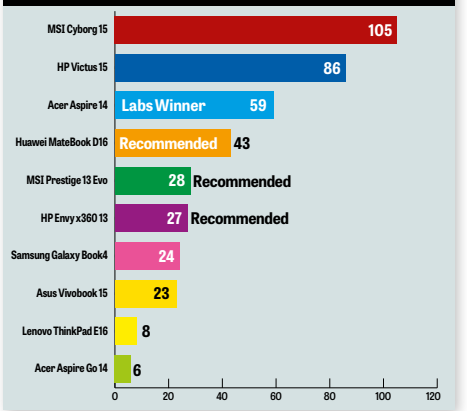
3DMark Time Spy



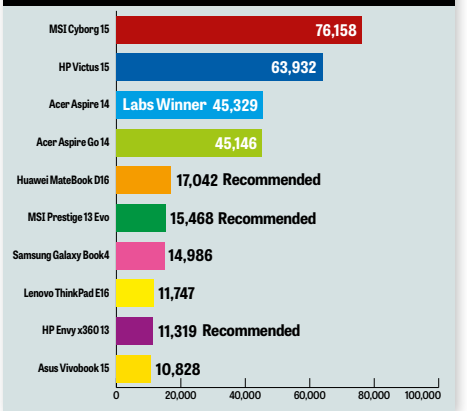
Shadow of the Tomb Raider (1080p Ultra, fps)



Shadow of the Tomb Raider (1080p Low, fps)

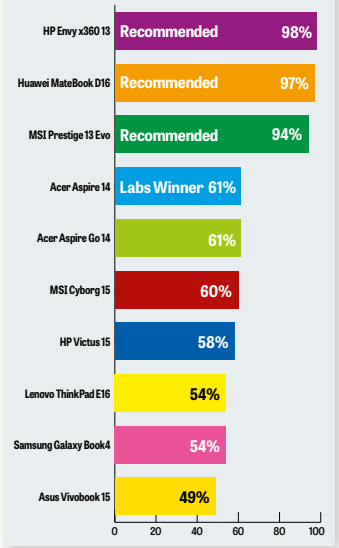


Geekbench 6 GPU compute

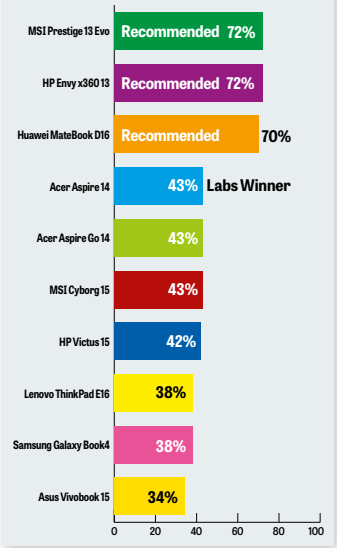


Display tests

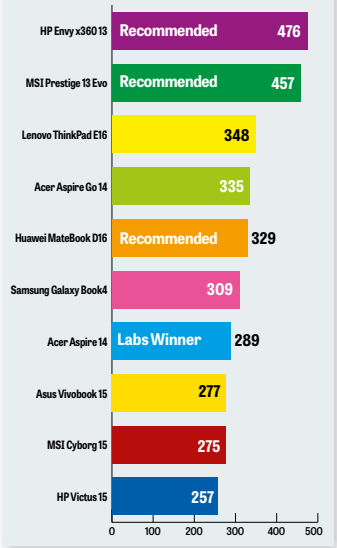
sRGB coverage



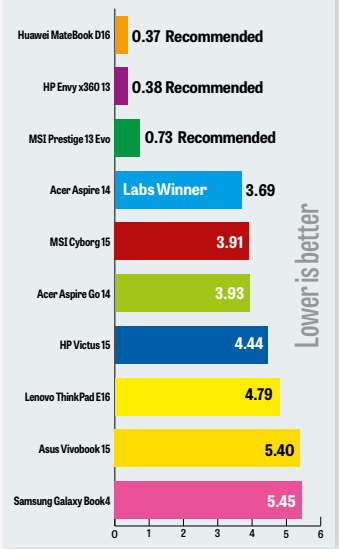
DCI-P3 coverage



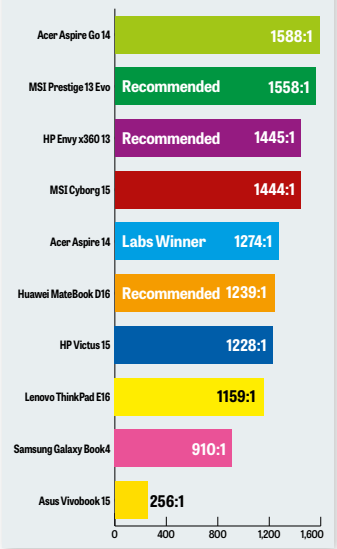
Peak brightness (cd/m²)



Average Delta E

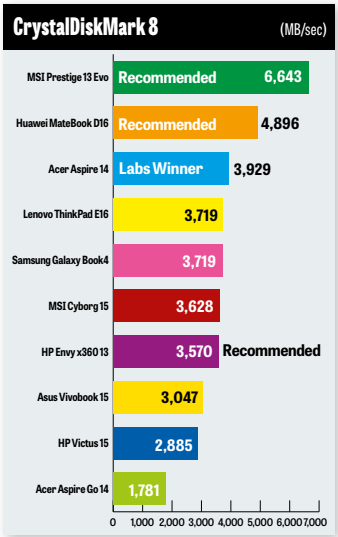


Contrast ratio



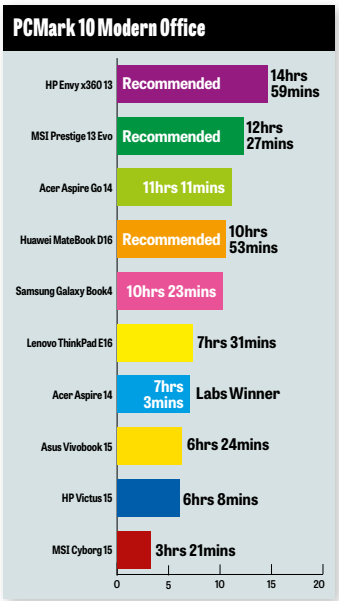
SSD tests

CrystalDiskMark 8 (MB/sec)

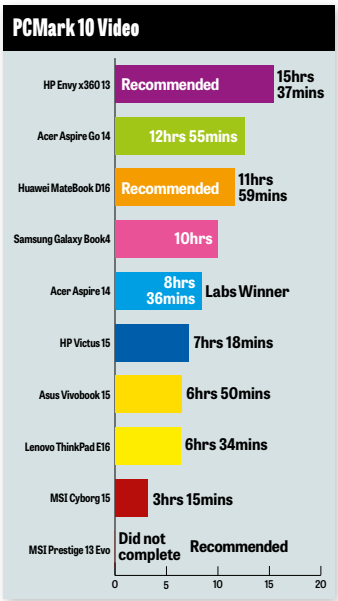


Battery tests

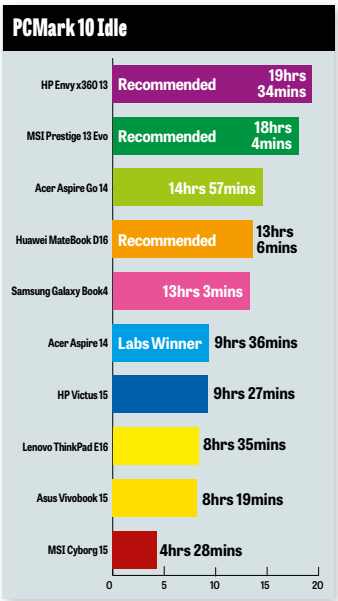
PCMark 10 Modern Office



PCMark 10 Video



PCMark 10 Idle



View from the Labs

Seeing is believing, and in this case Kevin saw – for the first time – truly all-day battery life

Until testing the 11 laptops in this Labs, my own notebook's lacklustre battery life often made me wonder if working far from a mains was actually a myth spread by evil technology journalists. In the pocket of AMD, Apple and Intel, they would spread this illusion of devices that kept on going, hoping to lure innocent buyers into buying their shiny new machines. But it turns out that my own laptop is just a terrible example.

In exactly 50% of my testing, the laptops kept running for over half a day, despite being asked to carry out automated tasks. Yes, it made those tests last somewhat longer than I expected, but it's such a positive for users. It shows what can be delivered by some devices when opting for modern, power-efficient components.

It's also a reminder that a laptop's power plan, although perhaps not worthy of date-night conversation, actually does matter. If you have a handful of hours to get some intensive work done, opting for Windows' Performance plan makes sense. But for less intense use on the right device, the Balanced plan rewards you with large amounts of uptime.

So while it's easy to ignore battery life in favour of all-out speed, I say don't. Make a note of your battery life needs and match your next laptop based on what it can offer. And think about the different scenarios, whether that's around the house, on holiday or for the daily commute into the office.

Take it from someone who's been caught short on a packed train, unable to charge, and having to work with Google Docs on their smartphone. ●

Kevin Pocock has written about technology for almost 20 years, on titles ranging from *Wired* and *Which?* to *Micro Mart* and the *Daily Telegraph*.

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pcpro.link/norton360

We've negotiated a killer deal with Norton. No subscriptions, just a one-off bargain price of £19.99 compared to the regular £179.99 charge. That buys you two years of cover from the powerful Norton Security suite across ten devices.

And because it's the Premium version, you get a host of extra tools. There's 75GB of cloud storage for secure backups, plus the full version of Norton Secure VPN, both to protect your identity and provide a way of watching British TV while abroad.

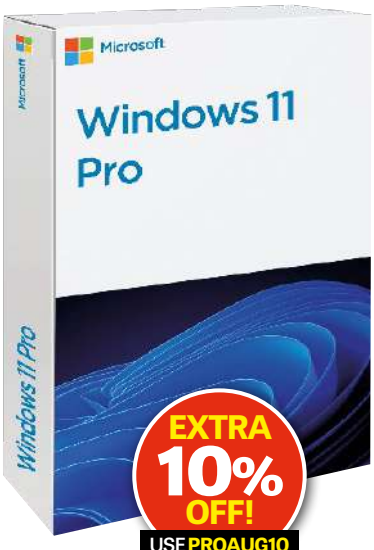
Norton Parental Control provides tools to see exactly what your kids are up to on their various devices, and you also get GPS location monitoring for Android and iOS.

To round things off, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals attempting to take photos with your webcam without your knowledge.

ALSO CONSIDER Avast Ultimate Suite 2023 for £29.99 (10 devices for two years) **SAVE 85%**

Windows 11 Pro for £79.99

pcpro.link/win11pro



EXTRA 10% OFF!
USE PROAUG10 AT CHECKOUT

Want to upgrade from Windows 11 Home to Windows 11 Pro? Or perhaps you're building a new PC from scratch, or looking to move up from Windows 7? Maybe you want to run Windows on your Mac? Whatever your motives, a Windows 11 Professional OEM licence is a great choice.

The first reason is simple: price. Microsoft charges £119.99 for a retail licence of Windows 11 Home, and a staggering £219.99 for Windows 11 Professional. By choosing an OEM licence – and avoiding the many dubious sources of licences you may find online – you cut that price substantially.

ALSO CONSIDER Windows 11 Home for £59.99 **SAVE 50%**

CCleaner 6 Professional for £14.99 (one PC, one-year licence)

tinyurl.com/359ccleaner6

CCleaner has a hard-earned reputation for being a brilliant way to bring an old computer back to its sparkling best, and we've negotiated a 50% discount on the Professional version. This tool will remove unwanted information, temporary files, your browsing history, huge log files and even the settings left behind by previously installed software.

SAVE 50%

One new CCleaner 6 feature is its Performance Optimizer. Unlike optimisation techniques found in other apps, the boost given by this can be measured in benchmarks. Performance Optimizer uses a three-step process, where it detects the apps and services you have running, along with background tasks and processes. Anything it deems unnecessary is put into sleep mode until it's needed. The result: better performance, better battery life on laptops.

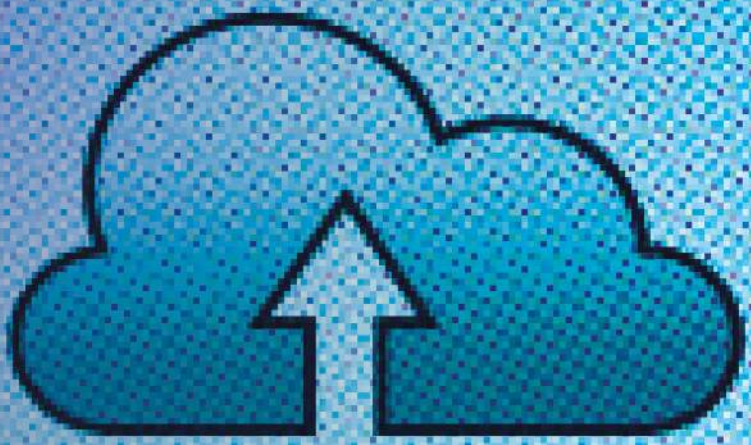
We also like CCleaner 6's improved software updater, which does a great job of ensuring the very latest versions of apps and drivers are installed. And it doesn't stop there, also including security tools such as a data eraser so you can make sure files and information are completely removed from your PC.

ALSO CONSIDER CCleaner 6 Professional Plus (3 PCs) for £24.95 **SAVE 44%**

Buyer's guide

Cloud backup 2024

Whether it's through attack or error, your business data is always at risk. Dave Mitchell explains how cloud services can add extra protection and puts four contenders to the test



Businesses are creating data at unprecedented rates, and those that don't protect it are taking some appalling risks and putting their very survival on the line. There's no such thing as "safe data", so it's essential that businesses implement a sound backup strategy to protect against unforeseen disasters.

The number of threats faced by businesses are increasing just as fast. Data breaches and ransomware attacks are always on the rise, but so are environmental disasters and crimes such as theft and burglary.

Backup doesn't need to be challenging, and the cloud makes it even easier as it provides an ideal location for essential off-site storage. The best data protection strategies use a hybrid combination of on-premises and cloud backup, which ensures that multiple copies of your data are maintained in different physical locations so it's always available for recovery.

The good news for SMBs is there are plenty of affordable solutions on the market with integrated support for on-premises and cloud backup. You don't even need to worry about sourcing cloud storage as we've chosen solutions from Acronis, Barracuda, Commvault and IDrive that all include it in the price.

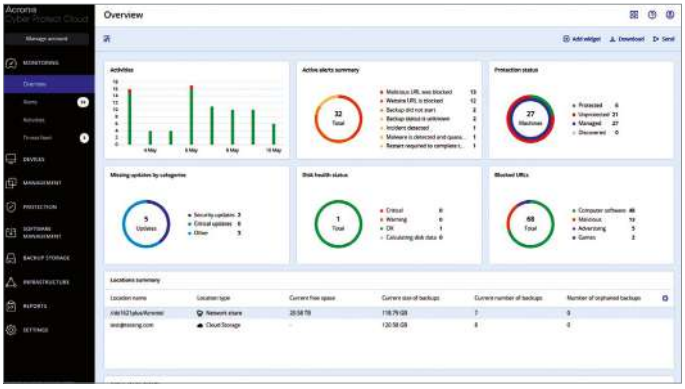
Parts of the process

A data protection strategy that relies heavily on human intervention is guaranteed to fail. All backup tasks must be fully automated and the four products in our guide will do this for you as they have built-in schedulers that automatically run jobs regularly.

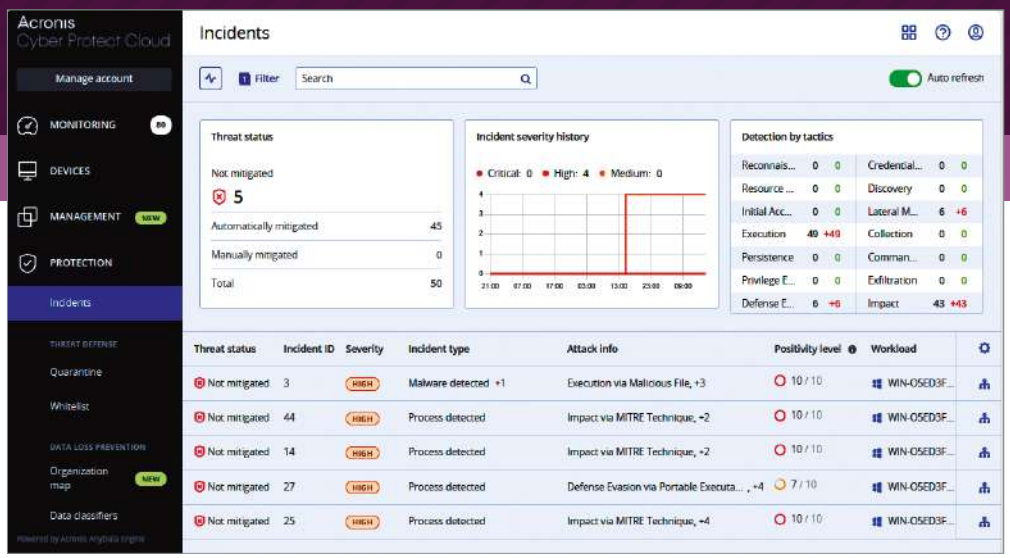
Backup frequency will be determined by your recovery time objectives (RTOs) and recovery point objectives (RPOs). RTOs determine the amount of time your business can comfortably survive without access to its systems, applications and data, while RPOs define the amount of data loss your business can tolerate.

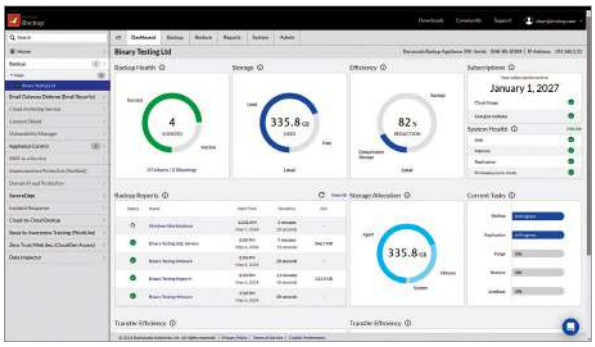
An RTO in hours will require a backup strategy that delivers much faster restore services than one measured in days. RPOs define the frequency of backup jobs – running one backup per day won't be enough if you can't afford to lose all the data created during the previous working day.

If you're worried about the impact multiple daily backups may have on production, look for a feature called "incremental

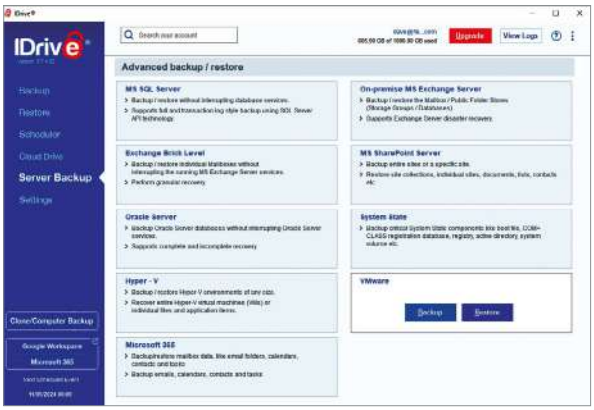


BELOW Acronis Cyber Protect delivers backup and cybersecurity in one product





ABOVE The Cyber Protect EDR service provides anti-malware protection



LEFT Barracuda's Backup 290 can be managed from the cloud

LEFT IDrive can back up apps as well as local and remote workstations

forever" as this can significantly reduce backup run times. All products start by running a full backup of selected data, but those that support this follow it with partial backups that only copy data that has changed since the last backup was run, so are faster and more space-efficient.

Storage is in the house

The most common backup strategy is "3-2-1", where you retain three up-to-date copies of your data, back it up to two different types of storage media and keep one copy off-site. On-site backups offer instant access to data for quick restores and provide insurance against internet outages, while the cloud portion ensures you can reach your data in situations where office access is denied or IT equipment gets stolen.

It's up to you what type of on-premises storage you choose, and we recommend using a dedicated system. SMBs will find a NAS (*see issue 356, p96*) appliance is an ideal candidate.

The appliance-based backup product in this guide already comes with internal disk capacity specifically for on-site storage, while the others allow you to use local network shares for this purpose. For lab testing, we use Synology's desktop NAS appliances configured with dedicated shares that we define to the backup product using their UNC (universal naming convention) path; for example, \\servername\share.

Pay dirt

As we've already mentioned, ransomware attacks are on the rise and smaller businesses that think they won't be of interest to hackers could be in for a nasty surprise, as this attitude makes them easy pickings. Backup products can't protect against these attacks, but they could mitigate them so you won't have to pay the ransom to get your data decrypted.

All good backup products offer a number of defences, and file versioning is one to look out for. This maintains a history of versions going back days, weeks and months. Should you receive a ransomware demand to decrypt your data, it may be possible to browse all file versions and recover data from before the attack that hasn't been encrypted.

The more devious ransomware attacks will attempt to gain access to the backup system and delete all backups before encrypting the source data. A solid defence against this is immutable cloud storage that, once written to, cannot be changed, overwritten or deleted. This is often referred to as a "3-2-1-1" strategy.

Some vendors offer "air-gapped" cloud storage as well. Managed by the backup product, this is a transparent process that copies backup data to a location in their data centre with no network or internet access effectively, isolating it from attack.

Home sweet home

Home working shows no signs of diminishing, and cloud backup products lend themselves well to protecting remote workers. Look for those that provide endpoint agents; these link up with your cloud account and back up systems directly to cloud storage. The best ones also offer iOS and Android apps for protecting mobile devices.

Don't think your job is done once your backups are up and running; you must regularly test all restore services. Businesses are legally required to run fire drills, and you should have the same mentality when it comes to data protection.

"A data protection strategy that relies heavily on human intervention is guaranteed to fail. All backup tasks must be fully automated"

Regular contingency testing will confirm your backups are working, data is retrievable, your RTOs and RPOs can be met and any unforeseen problems are ironed out before you need to use them for real. Creating a "run book" is another smart move as this will provide clear instructions for carrying out any type of data or system recovery even if key personnel aren't available.

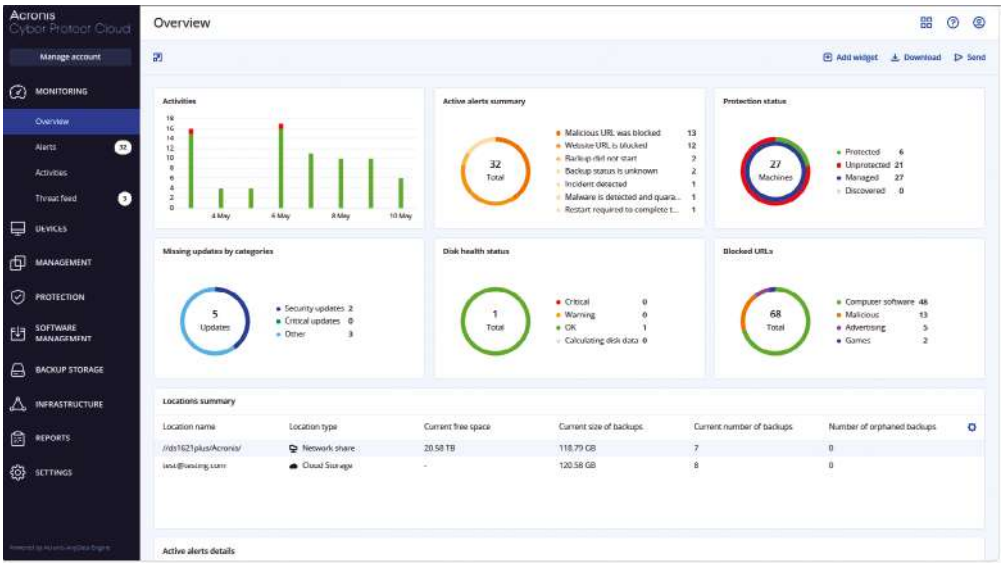
All businesses will have different data protection requirements, and the four products we've chosen are available as free time-limited trials (including the hardware model) so you can test them out first. They're all affordable options for SMBs, so read on to see which one will protect your business from data loss and disasters.

Acronis Cyber Protect 16 Advanced

Hybrid backup, endpoint protection and tough security measures all rolled into one easily managed solution

SCORE ★★★★★

PRICE From £95 exc VAT per year from acronis.com



Acronis' Cyber Protect teams up hybrid backup services with full-strength cybersecurity and endpoint protection. One subscription takes care of everything, and it's all managed from a single cloud portal.

Cyber Protect 16 Advanced takes the Standard edition and adds features such as Windows patch management, backup malware scans and an endpoint detection and remediation (EDR) service that provides event correlation, threat containment, incident investigation, kill chain analysis and endpoint rollback recovery. Ransomware protection comes with tamper-proof immutable backups and a compliance mode that stops malicious actors from changing account settings and deleting backups.

There are a lot of activities to keep track of, but the cloud portal helps by presenting a customisable dashboard. You have lots of widgets to choose from, including ones for protected system overviews, backup storage usage, vulnerable systems, alerts, detected malware, patch remediation status and blocked website categories.

Platform support is outstanding and includes Windows, macOS and Linux systems, iOS and Android mobiles, many popular business apps, ten virtualisation hosts, and cloud apps such as Microsoft 365 and Google Workspace. Agent deployment for workstations and servers is a lengthy affair, though, as they must be downloaded from the portal and manually installed, after which they generate a unique registration code and appear in the portal's devices page.

Hyper-V virtual machine (VM) backups require a dedicated agent installed on the host, and you now have two choices for VMware systems. You can install an agent VM directly on the host and register it with your cloud account or use the new Windows remote agent.

Applying settings is much simpler. You place similar systems in groups and assign protection plans that include your backup settings, encryption passwords, schedules and all cybersecurity settings. For hybrid backups, primary and secondary storage locations can be assigned. We used local Synology NAS shares for fast local backups and the Acronis cloud repository for off-site storage.

Synology NAS appliances can now be protected by a DSM agent app. It temporarily needed root access to register with our Acronis account, and we could then access the appliance from the cloud portal, create a protection plan and choose the shares we wanted backed up to the cloud.

Along with swift file and folder recovery services for remote servers and workstations, the portal provides an impressive range of restore features for Hyper-V and VMware. You can recover an entire VM back to its original location, as a new VM on the same host or another one. For even faster recovery, a temporary VM can be created on the host from a local backup.

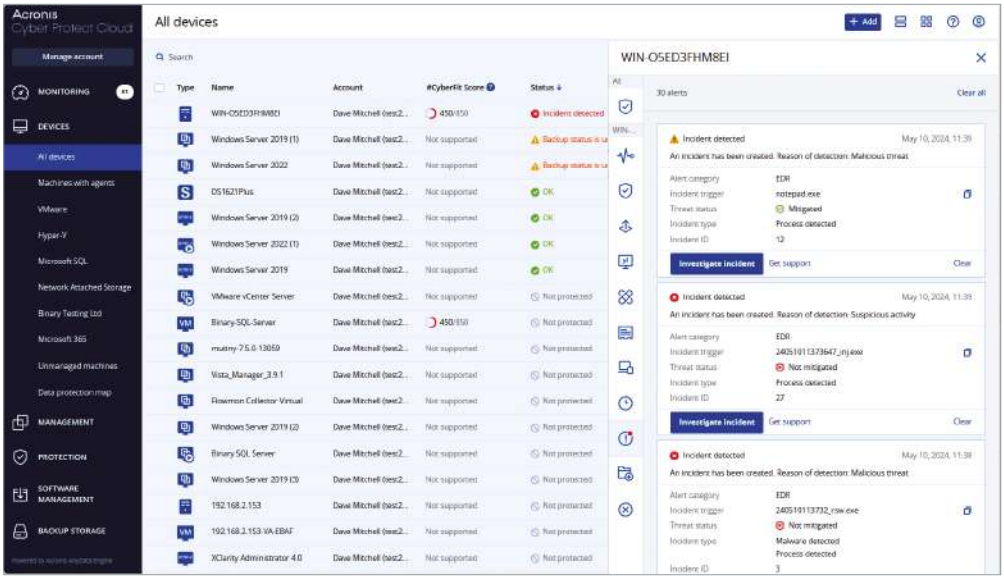
Within workstation and server plans, you can enable real-time malware scanning, apply URL filtering using up to 44 categories, schedule vulnerability assessments, run patch management remediation tasks and enforce removable device controls. When EDR is activated, you can view all incoming alerts from the portal, see lists of all incidents filtered by severity and mitigation status and browse a threat investigation page which provides a kill chain diagram, details of how the attack developed and the processes it interacted with.

Businesses that want all their data backup and cybersecurity in one place will love Acronis Cyber Protect 16 Advanced. Its flexible subscriptions keep costs under control, the EDR service stays one step ahead of cybercriminals and it's easy to manage.

ABOVE **Platform support is extensive and the EDR service keep ransomware attacks at bay**

PC PRO RECOMMENDED

"Along with swift file and folder recovery services, the portal provides an impressive range of restore features"



BELOW **The Cyber Protect cloud portal provides a wealth of information about protected systems**

REQUIREMENTS

On premises: Windows 10 Pro/Enterprise • Windows Server 2016 upwards • Debian Linux 12 • Raspbian (SBC only)

Barracuda Backup 290

This easily managed backup appliance is a one-stop shop for all your on-site and cloud data protection needs

SCORE ★★★★☆

PRICE From £2,000 exc VAT from barraguard.co.uk

Businesses worried about managing a hybrid data protection strategy may want to consider Barracuda's Backup appliances, as they do everything for you. These all-in-one physical and virtual solutions provide on-site backup, cloud replication and full data restoration services, as well as optional site-to-site replication, all managed from one cloud portal.

Barracuda offers a wide choice of hardware appliances, with the entry-level Backup 290 on review presented as a low-profile 1U rack appliance fitted with a single 2TB SATA hard disk. This may not sound like very much, but the appliance's variable block-level deduplication is very efficient; during testing we backed up 1.7TB of data, which Barracuda squashed down to 331GB for an 82% reduction.

Prices for the Backup 290 start at £2,000, with unlimited cloud storage costing £996 per year. Barracuda's Energize Update service costs £335 per year, with an Instant Replacement subscription adding a further yearly cost of £480.

To install the appliance, you initially connect a local monitor and keyboard and link it to your Cloud Control account. Barracuda provides agents for Windows, macOS and Linux in the portal, and it's good value as the price includes support for unlimited clients as well as a number of common business apps.

You use the same agent for all Windows workstations and servers. Once installed, we declared each system as a backup source. The beauty of this solution is that during job creation, you tick one extra box so local backup jobs are automatically replicated to the cloud.

The agent identifies all hosted applications and offered us options to select SQL Server databases and virtual machines (VMs) on our Windows Server 2022 Hyper-V server. An agent isn't required for VMware hosts as we declared our vCenter server using its IP address and were presented with all VMs on our managed ESXi servers for selection as backup sources.

Once systems are registered, you can assign them to the default backup schedule, which automatically backs up everything on them once a day. It's easy enough to create custom schedules, assign specific systems and items, and repeat jobs as often as every 15 minutes.

ABOVE The Backup 290 is fitted with a single 2TB SATA hard disk

PC PRO RECOMMENDED

"Block-level deduplication is very efficient; during testing we backed up 1.7TB of data, which Barracuda squashed down to 331GB"

Barracuda employs an "incremental forever" system, which runs one full backup for each host followed by regular incrementals. Ransomware protection is provided as you can use the default retention policy for all hosts or apply custom ones that define the daily, weekly, monthly and yearly periods you want data kept for.

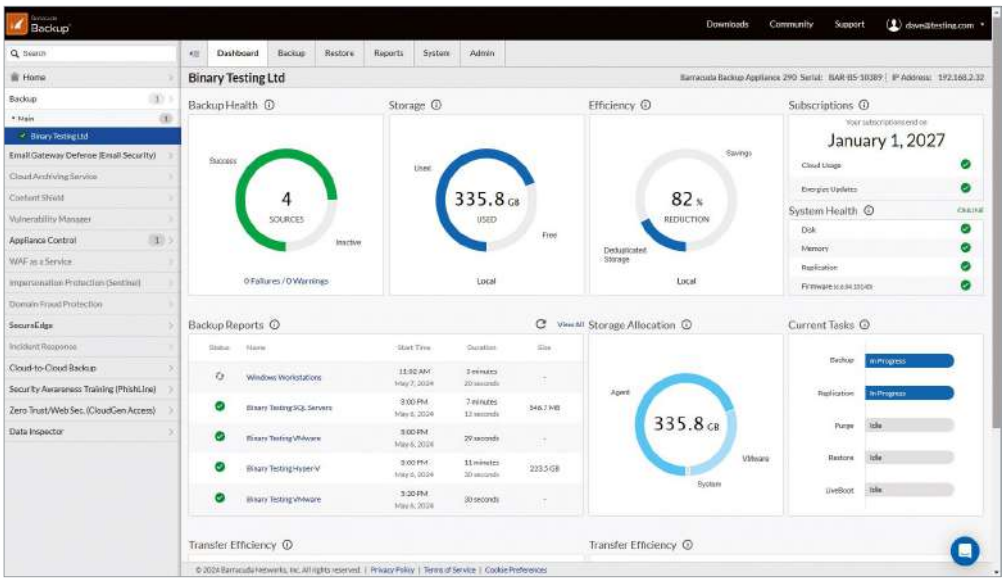
For file recovery, we selected systems from the portal, chose files and folders and restored them to their original location or to another system. The same window provides access to the cloud repository, where the Download option copies the data back to the system running the Cloud Control portal.

We could restore selected Hyper-V and VMware VMs directly from the appliance to their respective hosts or to alternative locations, and if the appliance isn't available you can download their virtual disks from your cloud repository. An Energize Update subscription enables the LiveBoot feature so you can swiftly restore VMs directly to the appliance if the hypervisor is down.

The Cloud LiveBoot feature has an Instant Replacement subscription and allows VMs to be hosted in Barracuda's cloud for up to seven days for testing, backup validation and file recovery. Internet outages are covered, too, as the appliance has a local web console that provides restore browser and Live Boot management tools.

Barracuda's Backup 290 makes light work of managing a hybrid data protection strategy and is an attractive option for time-poor SMBs. It's simple to deploy and manage, the block level deduplication can make big storage savings, and it offers an impressive range of data recovery features.

BELOW The cloud portal keeps you informed of all backup activity



SPECIFICATIONS

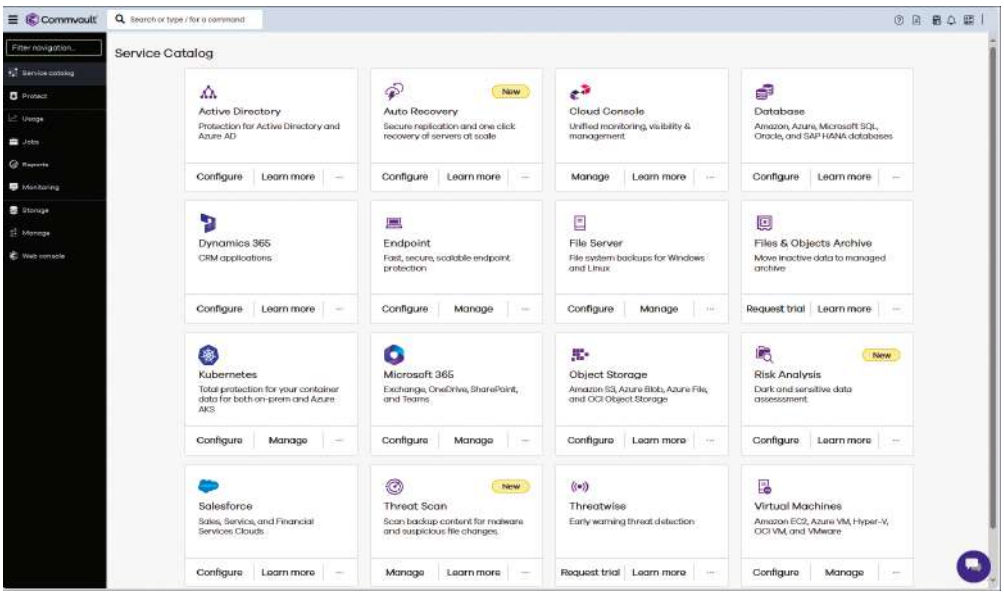
1U rack chassis • 2TB SATA hard disk • Gigabit, 2 x USB 2 • VGA

Commvault Cloud

A secure cloud backup solution with a data protection module for every business requirement

SCORE ★★★★½

PRICE Microsoft 365 module, from £1.20 exc VAT per user per month from commvault.com



A highly modular approach makes Commvault's Cloud an attractive choice for businesses that want a hybrid backup solution they can tailor precisely to their needs. Originally launched a few years ago as Metallic and now integrated into Commvault's cyber resiliency and recovery cloud platform, it comprises 16 distinct components so looks to have every data protection requirement covered.

For essential off-site backup, you can use Commvault's cloud storage as a backup destination or choose from 26 third-party providers including Amazon Web Services (AWS), Microsoft Azure and Google. Commvault gives ransomware attacks a hard time, as its Azure-based cloud storage is air-gapped and immutable, with modules now provided for risk analysis and backup content malware scans.

The Security IQ feature presents a security posture rating plus options to enforce extra authorisation for restores and deletions. The unusual file activity service alerts you if it detects ransomware attacks and presents the last good recovery point for swift data recovery.

The cloud portal presents a service catalogue list, and selecting a module takes you to a dedicated configuration page. Plenty of help is at hand as each one provides details of all prerequisites and clear setup instructions.

After assigning the systems, applications or services the module is to protect, you choose your storage locations; for hybrid backup, Commvault supports local storage or network shares as the primary location and a cloud repository as the secondary stage. Next, you assign a backup plan that defines your recovery point objective (RPO), backup window and data retention periods.

We wanted to protect the lab's Hyper-V and VMware hosts, which required the Commvault gateway component installed on a Windows Server host on the same network. Downloaded from the portal, this manages communications between sources and destinations and handles all caching, deduplication and hash tables. For Hyper-V backups, you'll also need Commvault's VSA package installed on each host server.

We declared a Synology NAS for our primary backup location, used Commvault's cloud for secondary storage, and each plan started by backing up selected virtual machines (VMs) to our NAS appliance. On completion, they ran an auxiliary job to replicate the local store to the cloud, and the transfer process is speeded up by only sending deduplicated data.

VMware recovery services are outstanding: we could browse and restore guest files, the entire VM or its VMDK files. The live recovery and live mount services can quickly reinstate a failed VM, with the latter loading them directly from a backup on primary storage.

A fine choice of cloud-to-cloud backup modules are available, and we found the MS365 option a cinch to deploy. You do need to authenticate separately with Exchange, SharePoint, OneDrive and Teams, but the entire process is handled very smoothly and we had our entire MS365 account backed up in 15 minutes. For item recovery, you select the required MS365 component, choose a recovery point, view all available versions and restore it to the original location or another MS365 user.

The Endpoint module supports Windows, macOS and Linux clients. Once users have installed Commvault's Edge Monitor app and logged in to their account, it applies your predefined plan. This backs up their system to the cloud, creates a local drive letter for drag-and-drop restores and provides access to a personal self-service web portal.

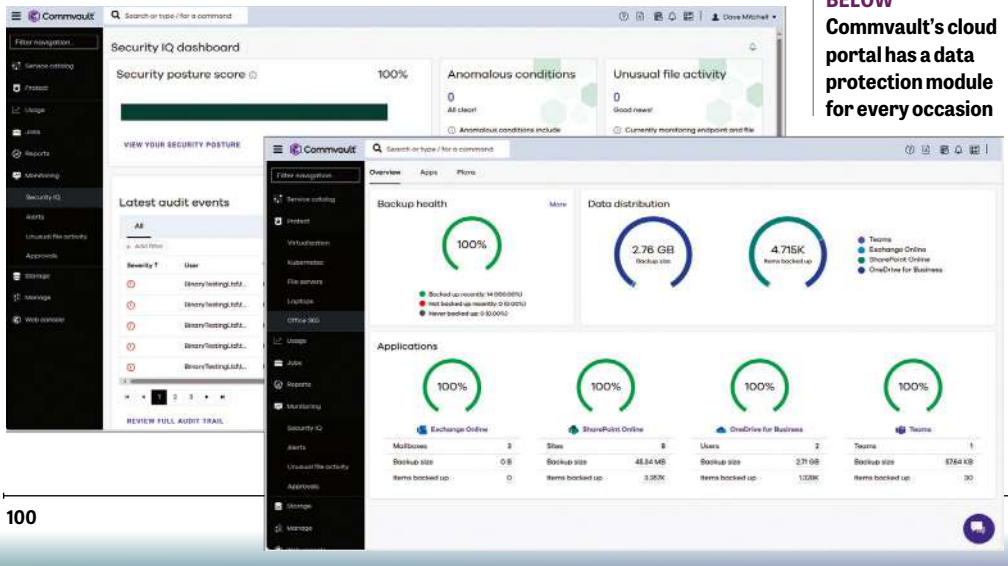
Pricing could be more transparent, but Commvault Cloud is a great choice for businesses that want a highly customisable cloud backup solution. It offers an impressive range of easily deployed modules so you only pay for what you need, and it has a keen focus on data security and ransomware protection.

ABOVE The Security IQ feature keeps your data safe

PC PRO RECOMMENDED

"VMware recovery services are outstanding: we could browse and restore guest files, the entire VM or its VMDK files"

BELOW Commvault's cloud portal has a data protection module for every occasion

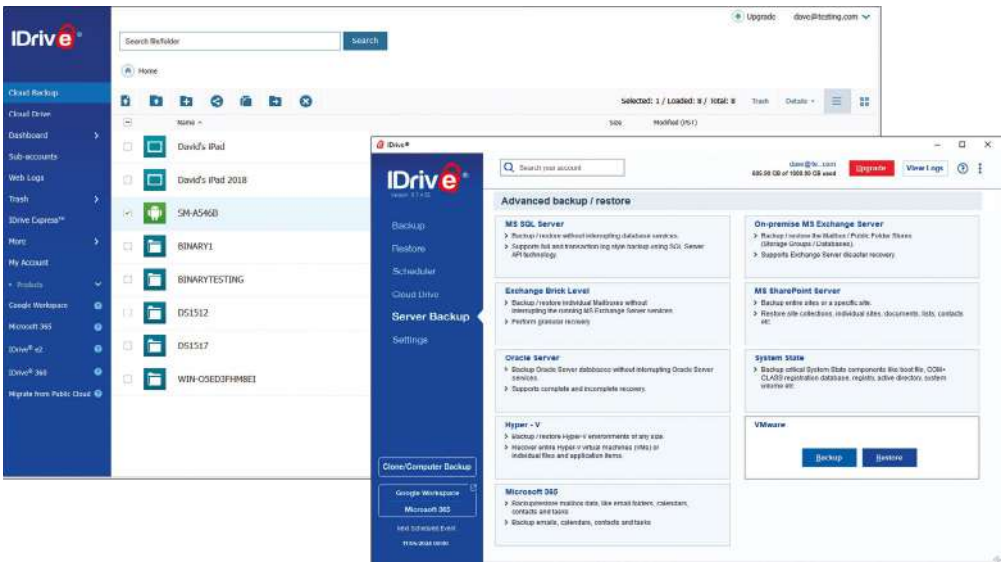


IDrive Business

Perfect for SMBs, this hybrid backup service offers a wealth of features and platform support at a great price

SCORE ★★★★★

PRICE 5TB, £838 exc VAT per year from idrive.com



IDrive Business is a great cloud backup solution for SMBs concerned about hidden costs as its subscriptions are based only on cloud capacity. Available in a wide range of flexible plans, you can start small and scale up as and when you need to.

Prices start at only £56 per year for 250GB, rising to £838 for 5TB, with options to go up to 50TB and beyond. It has even more appeal as all plans include unlimited workstation and server support so you can secure Windows, macOS and Linux desktops, iOS and Android mobiles, Windows Server, Hyper-V and VMware hosts, and business apps such as Exchange, SQL Server, SharePoint and Oracle.

Features keep on coming as IDrive's hybrid backups can secure data to local drives or network shares, apps are provided for protecting Qnap and Synology NAS appliances, and it offers disk image backups, cloning and continuous data protection (CDP). Cloud file syncing between IDrive computers is also included, and subscriptions enable an equal amount of sync space.

The only optional features are cloud-to-cloud (C2C) backup services for Google Workspace and Microsoft 365. These are managed from a dedicated portal, with the MS365 component costing £16 per user per year to secure OneDrive, Exchange, SharePoint and Teams accounts.

Client deployment is simple: you send email invitations from the portal, which provide links for users to create backup accounts, select AES-256 encryption and download the desktop app. Businesses with remote workers will find a lot to like here as the price includes unlimited users, and admins can remotely access their desktop app, create or edit backup jobs, set schedules and run restore tasks.

The client opens with a default backup set for common files and documents. We modified file and folder sources by adding or deleting them in the Backup pane and scheduled tasks for regular intervals. Files and folders can be easily restored using the local agent or web portal, and IDrive provides ransomware protection by retaining up to 30 file versions.

To secure our VMware ESXi virtual machines (VMs), we provided the IP address and credentials of our vCenter host and selected VMs from the list presented. Jobs default to running hybrid local and cloud backups and, for the former, IDrive can use a storage location on the system running the app or a mapped drive.

ABOVE Remote users can be managed from the web portal

PC PRO A-LIST

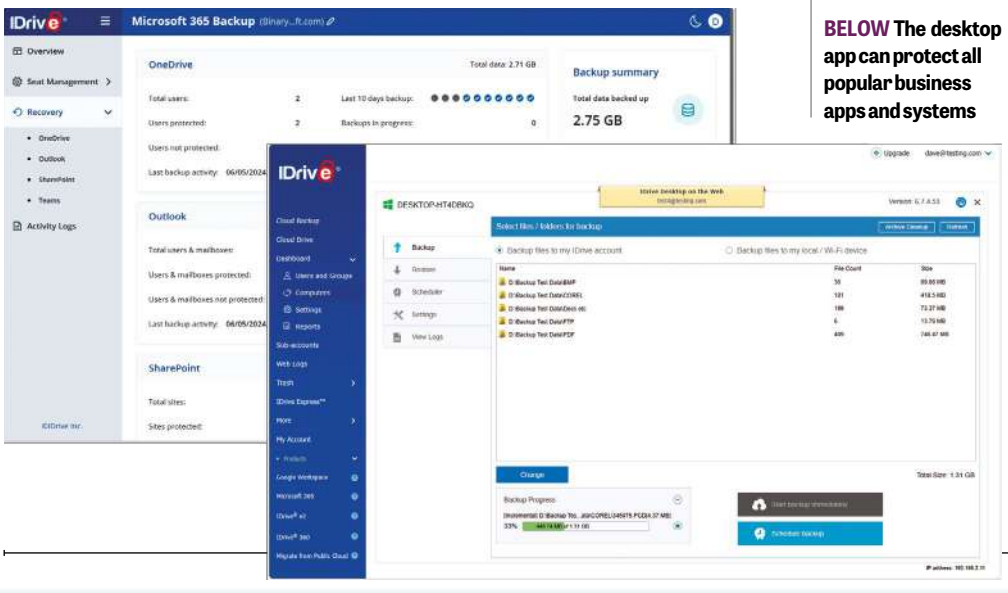
"IDrive Business is a top cloud backup choice for SMBs that want to protect on-premises systems and remote workers"

The same procedures apply for securing local SQL Server databases, while Exchange Server and Hyper-V VM backups need the desktop app installed directly on the hosts. When restoring data to any of these hosts, IDrive requires access to the local backup folder and, if it isn't available, you can copy the relevant files back from cloud storage using the client or web portal.

The Microsoft 365 protection service is just as easy to use; once we'd authorised access to our account, it immediately started full backups for the four suite components and all users. The dedicated portal can be accessed directly from the main IDrive web console or desktop app and provides an overview of all activities and protected items.

You can't control the schedule as IDrive automatically runs incremental backups three times a day, but you can run extra manual backups for selected users and teams whenever you want. The portal's recovery panel is easy to use, and we had no problems finding and restoring items such as emails for Outlook users, OneDrive files and Teams documents.

IDrive Business is a top cloud backup choice for SMBs that want to protect on-premises systems and remote workers. Platform and business app support is outstanding, it's easy to use and the simple capacity-based subscriptions are incredibly good value.



BELOW The desktop app can protect all popular business apps and systems

Canon imageFormula DR-S250N

This versatile desktop scanner teams up clever driverless scanning with good speeds and output quality

SCORE ★★★★½

PRICE £426 exc VAT
from printerland.co.uk

Canon's imageFormula DR-S250N desktop scanner is designed with accessibility in mind, and can be used without installing any apps, drivers or software. This clever attribute comes courtesy of its CaptureOnTouch (COT) Lite web interface, which means if a networked device can load a browser, it can pull in a scan.

The web console opens with a simple home page. Clicking on the Scan button presents a menu for selecting colour or greyscale, a page size, a resolution up to 300dpi, simplex or duplex scans, double feed detection and a passport mode. From the Output page, you choose PDF or JPEG formats and enable OCR with a choice of ten languages.

Mobile users walk up to the scanner, select the COT Lite Web option and scan the QR code in the display panel. This worked fine on an iPad: scanning the code using its camera loaded Safari with the web page ready for action.

Remote scanning is effortless. We pulled in scans from a Windows 11 desktop and, on completion, each one was placed in a ZIP file in the Downloads folder. Administrators can view all scanner settings from the COT Lite interface, apply function restrictions, control user access with passwords or PINs and save jobs to the scanner's display panel, which sends them as emails or to network shares and FTP servers.

The DR-S250N claims speeds of 50ppm at 200dpi for colour and mono scans, has a capacious 60-page automatic document feeder (ADF) and a hefty 9,000-page daily duty cycle. Unlike the wireless-enabled DR-S150 model, it only has USB-A and gigabit connections, and Canon has replaced the 4.3in colour touchscreen with a much smaller mono OLED display and set of control buttons.

It delivers all the traditional network scan services you'd expect. TWAIN-compliant apps can remotely acquire it and the CaptureOnTouch 5 Pro software provides plenty of scan workflow features.

Software installation on a Windows 11 desktop took 15 minutes with the downloadable utility adding the TWAIN driver, the COT software and a driver settings tool. Mobile users are covered as Canon provides free COT iOS and Android apps.

LEFT The DR-S250N provides good scan management tools

ABOVE The DR-S250N can be used without installing any apps, drivers or software

For testing, we networked the scanner and selected it from the COT system tray menu. Its document profiles are great for streamlining scan operations as these combine settings for colour or greyscale output, resolution, blank page skipping and image rotation.

Output profiles determine where scans will be sent, and along with support for local and network folders, the installation routine pre-installs nine extra plug-ins. These allow COT to send scans to user-defined apps, printers, FTP or SharePoint servers and email, plus Google Drive, OneDrive, Dropbox and SugarSync cloud storage.

Profiles convert scans to PNG, JPG, TIFF and common Office formats, while OCR is automatically applied when PDF is selected. This is the Pro version, which provides batch separation controls using functions such as page counts, barcodes and zonal OCR.

Shortcuts combine document and output profiles for one-tap scanning and can be assigned to any of 100 job numbers that appear in the scanner's display panel. Walk-up scanning operations are easy: you simply choose a PC from the main menu and select a job from the list presented.

The DR-S250N easily achieved its quoted speeds, with a 30-page sheaf of bank statements quietly scanned at 51ppm for 200dpi greyscale and colour, while 300dpi returned speeds of 51ppm and 42ppm. Greyscale and colour scans at 600dpi returned 21ppm and 10.5ppm, but unless you're scanning photos you won't need such a high resolution as 200dpi is fine for document archiving and the OCR module correctly converted fonts to 6pt for searchable PDFs.

"The DR-S250N easily achieved its quoted speeds, with a 30-page sheaf of bank statements quietly scanned at 51ppm"

Canon's imageFormula DR-S250N delivers a scan-friendly package at a good price. Wi-Fi support would be nice, but the COT Lite web console makes driverless scanning a breeze, performance is on the money and the CaptureOnTouch software provides great scan management features. **DAVE MITCHELL**

SPECIFICATIONS

600dpi A4 colour scanner • 50ppm at 200dpi mono/colour • simplex/duplex • 60-page ADF • 4cm mono OLED • USB-A 3.2 Gen 1 • gigabit Ethernet • 9,000 pages per day • external PSU • Canon CaptureOnTouch V5 Pro and Driver Setting software • 291 x 267 x 242mm (WDH, closed) • 3.4kg • 1yr hardware warranty

Ruijie Reyee RG-RAP2260(E)

A top-value Wi-Fi 6 AP with good performance, excellent cloud management and slick provisioning services

SCORE ★★★★★

PRICE £160 exc VAT
from broadbandbuyer.com

Ruijie Networks isn't very well known in the UK; this network infrastructure provider has traditionally focused on the enterprise and carrier markets. Its Reyee sub-brand aims to radically change this perception as it presents SMBs with a huge range of affordable networking products.

The Reyee portfolio comprises modular and fixed-port switches, routers, firewalls and wireless APs, and a key feature is they can all be managed from Ruijie's free cloud portal. UK supplier Broadbandbuyer takes this a stage further, as it offers a complete cloud provisioning service so you just plug them in and go.

On review is the RG-RAP2260(E) AX3200 Wi-Fi 6 access point (AP), which claims top speeds of 2,402Mbits/sec on its 5GHz radio and 800Mbits/sec on the 2.4GHz band. It doesn't support the high-speed 160MHz channels but offers a 2.5GbE multi-gig LAN port, which requires a PoE+ power source, and its second gigabit LAN port can be used to network other wired devices.

To give us the full Ruijie cloud experience, Broadbandbuyer also supplied an RG-EG105G-P V2 five-port router and RG-ES206GS-P four-port gigabit PoE+ switch.

ABOVE **The Ruijie Reyee RG-RAP2260(E) comes with two LAN ports**

Provisioning starts before you even see the products: we filled in a secure online questionnaire about our networking requirements, confirmed the product order numbers and received a link to our personal portal, which was prepared with a project ready and waiting.

The products duly arrived and, after connecting them together, they appeared online in our portal's project workspace. The router was already configured with DHCP services on the LAN as per our request, and the AP started broadcasting our previously configured SSIDs.

To ensure there were no bottlenecks in our real-world speed tests, we temporarily hooked the AP up to the lab's Zyxel XS1930-12HP 10GbE multi-gigabit PoE++ switch and used a Dell Windows 11 workstation with a TP-Link Archer TBE550 Wi-Fi 7 PCI-E adapter. Performance was good, with large file copies between the client and a 10GbE-connected Windows server returning average close-range speeds of 117MB/sec, dropping to 87MB/sec with the AP placed ten metres away in an adjoining room.

The Ruijie Cloud portal is easy to use and, unlike Netgear's Insight and Zyxel's Nebula services, it doesn't require any subscriptions or extra licence packs. Its home page lists all projects – essentially your sites – and selecting one takes you to a dashboard where the Workspace view shows all associated devices and topologies, with quick action icons for creating SSIDs.

Projects are clearly designed to handle large sites as they support up to 32 SSIDs. Each one can use one or both radios, enforce WPA2 or the stronger WPA3 encryption, apply client isolation so wireless users can't see each other and set client and SSID upload and download rate limits.

For guest wireless networks, you can present custom captive portals with your own logos, background images and messages. A variety of authentication methods can be applied and if you opt for one-click logins, you can set limits on when and how often a guest can log in.

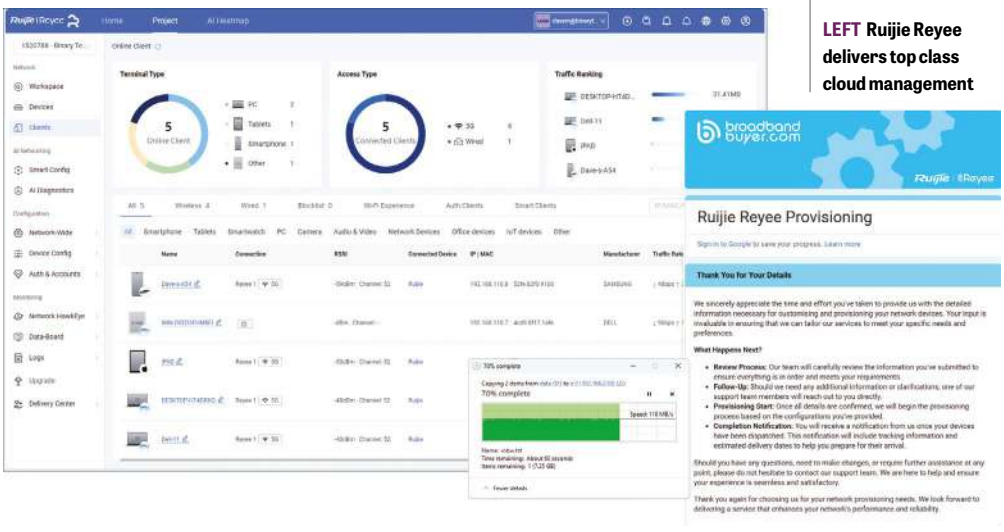
Monitoring services are outstanding, with the client view identifying devices and categorising them as PCs, tablets, smartphones, IoT, cameras and more. The Smart Config feature helps create wired and wireless VLANs and apply access controls, while the AI Diagnostics service scans the network, highlights faults and provides root cause analysis.

PC PRO RECOMMENDED

"Monitoring services are outstanding, with the client view identifying devices and categorising them as PCs, tablets, phones and more"

Network HawkEye provides detailed Wi-Fi experience, load and channel health graphs and more for gateway and WAN status. The Data-Board delivers graphical network reports showing areas such as client summaries, traffic rates, AP loads and captive portal usage, and automated firmware upgrade services are also provided.

Ruijie Reyee clearly has an eye on value as the competitively priced RG-RAP2260(E) delivers plenty of business-class features and an impressive performance. The Ruijie Cloud adds extra appeal as this totally free service offers an incredible range of remote network management and monitoring tools, while Broadbandbuyer's provisioning service does all the heavy lifting for you. **DAVE MITCHELL**



LEFT **Ruijie Reyee delivers top class cloud management**

SPECIFICATIONS

AX3200 dual-band 2.4/5GHz 802.11ax • 4x4 MU-MIMO • internal aerials • 2.5GbE LAN/802.3at PoE+ • gigabit LAN • 12V DC input (adapter not included) • ceiling/wall-mounting plate • 220 x 220 x 35mm (WDH) • 1.1kg • 3yr hardware warranty

Five ways to get cloud computing wrong

Don't let your migration projects go up in smoke. Steve Cassidy runs through the blunders to avoid

Cloud computing is everywhere. Everyone's doing it, and you can bet that a whole lot of people are getting it wrong in some way.

Before we look at how, though, let's start off by making sure we get the definition of "cloud computing" right. It matters, because you can't hope to have a successful relationship with the cloud if you don't know what it actually consists of.

To be fair, the general conception of the cloud has been fuzzy ever since services such as Amazon's EC2 started marketing to non-technical users. Prior to this I had been present in technical meetings and conferences where we all understood that "the cloud" meant a particular set of architectures presenting a particular set of services. But once marketeers started trying to sell the idea to managers, a more nebulous vision of the cloud began to take hold, as an all-capable, omnipresent yet invisible fabric that somehow runs the internet and anything else you want it to.

In fact, you can mostly understand cloud computing as a combination of three technological concepts; namely, hosting, virtualisation and DevOps. There's nothing magical about any of them, but when combined in the right ways they add up to something a lot more powerful than their individual parts. It's called "the cloud" not because it's insubstantial, but because to deliver a scalable, managed, flexible hosting service, the technology draws on a vast number of fungible, commoditised servers, no different from one another than raindrops in a... well, you get the idea.

With a proper sense of what the cloud is, we can start to understand how some businesses get it wrong. The mistakes detailed below are all ones that I've observed in the wild – although they've been diplomatically anonymised to protect the guilty.

Mistake 1
Unrealistic targets

Early in the cloud era I ran into a CEO who had enthusiastically bought into the cloud vision. She didn't really understand all the details, but she loved the idea of getting rid of all her on-site servers, which she had been assured was achievable by switching to cloud services.

What no-one had apparently told her was that, especially at that time, an "achievable" cloud project could mean several years of hardcore R&D. Most migrations in the fledgling days of cloud services involved considerable hacking around with both the outgoing systems and the incoming cloud stack.

That hasn't entirely changed today. I still sit through pitches from high-flying systems integrators, promising the Nirvana of "headless" or "serverless" operation, without addressing the cost and effort required in moving business-critical services into new distributed architectures and virtual environments. Nor, for that matter, do they seem to feel much need to explain the actual advantages of such approaches – they're justified by their mere cloudiness.

"If you're expecting to keep everything running as it did in your old server room, you're setting yourself up for failure"

The fact is that there are frequently plenty of false starts and bodges on the road to a successful cloud project. If you're expecting to simply switch over to the cloud and keep everything running exactly as it did in your old server room, you're setting yourself up for frustration and failure.

Mistake 2
Restrictive contracts

It used to be the photocopier business that swept the awards every year for the least customer-friendly legal relationship. Today, the cloud sector gives it a run for its money. Because the provider, nominally, provides

nothing more than the pipe and the platform, you can expect little in the way of hand-holding and consumer protections. I've seen cloud migrations where the new server VMs fired up on day one and ground to a halt less than 24 hours later because the business had woefully underestimated its resource requirements and the virtual hard disk was full – and of course the provider's only solution was a costly expansion of resources.

The lesson here is partly to apply some careful calculation and testing while figuring out your needs. Also, though, it's to read the small print: the rigid three-year contract the company had signed made this a far more expensive mistake than it might otherwise have been. Nor was it viable to simply bail on the deal: another classic gotcha is a date clause that makes it difficult to exit the contract when you want to, as distinct from when it might suit the provider.

Even after you pore over the details, other risks may arise from contracts you never even see, such as agreements between your cloud provider and its own upstream providers. In these days of everything-as-a-service, there's nothing stopping some entrepreneur building up a cloud business without owning any assets at all, relying on remote compute service providers, contract programmers and orchestration specialists to present something that looks like an entirely conventional old-school hosted server, but which is, behind the scenes, held together by half a dozen outsourcing agreements.

It's important, therefore, to understand who you're dealing with, and how you're protected.

A heavily subcontracted service may be cheap and flexible, but if it runs out of money or loses one of its suppliers, the people who have physical possession of your VMs and data may well be several contracts away from you and probably won't even know you exist.

Mistake 3
Orchestral manoeuvres

Orchestration is a cloud management buzzword with a simple definition: it's the technology that provisions, starts, manages and stops fleets of virtual machines automatically, in response to inputs from various types of sensor.

But while the idea isn't complicated, the implementation certainly can be.

"I've seen cloud migrations where the new server VMs fired up on day one and ground to a halt less than 24 hours later"

Orchestration spans the entire stack of machinery that represents your cloud investment, from a wattmeter on the incoming power to a software "sensor" that tracks how many sessions from the consumer internet are currently being handled.

Orchestration is also a core requirement for being able to run your VMs "serverless"; or, to avoid that misleading term, let's say it's necessary if you want to spread your cloud estate across more than one provider or server location. This is highly recommended as a way to avoid getting tied into one cloud vendor's specific hardware and software stack; it's a good idea to regularly practise moving things around inside the virtual environment even when there's no obvious need to do so, as a sort of 21st-century equivalent of the office fire drill.

Salespeople might not want to talk about orchestration, partly because it's not exactly an end feature in itself, but also because they don't want you to be able to easily jump ship at the drop of a hat. If someone tries to tell you that orchestration is a non-issue, that's an early red flag. In fact, you can be sure that any cloud provider has plenty of orchestration going on: the question is what scope you have to use it for your own purposes.

Lots of simple providers offer what I call the Gmail model, where you can log in and access your services, but there's no "go faster" button – no way for the customer to tune their session to better suit their working needs. Of course, I understand why this would be the case with free email services, because otherwise everyone would just turn themselves up to 11 at the very first opportunity. But when you're entrusting your business to cloud resources, and paying for the privilege, it's an option you should have at your disposal.

Mistake 4
Sense of scale

Why do you want to move to the cloud? Most people have a general sense that cloud computing is cheaper, more versatile, easier to manage and so forth, but it's always worth asking precisely what the main driver is behind a specific project. Some companies do it so they can leave their old kit unmolested while bringing new apps and services online. For others, it's access to the privileged ring of business-to-business data centres at fat-fibre-link speed. Interestingly, I've seen very few cloud proposals incorporate even a passing reference to the notion of scaling.

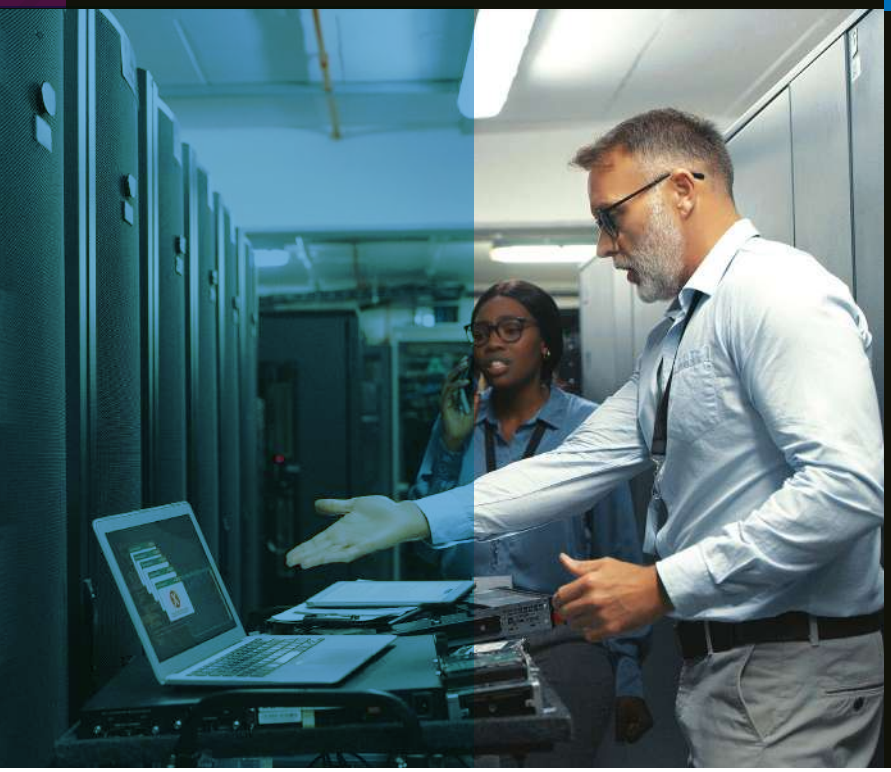
At its simplest such a reference might seem superfluous. Scaling just means matching the compute provided to the demand encountered, which sounds like something you'd do as a matter of course. But businesses attracted by the idea of on-demand computing need to realise that their own demand is highly variable.

In fact, one of the greatest benefits of the cloud is the scope it gives you to scale up, or scale out, as needed. To clarify the distinction, a "scale up" response to a resource demand means throwing more physical server resources at the problem – so your VMs receive more memory, more cores or more disks as managed by your orchestrator software. To scale out is easier, but demands much more preparation; this is where you add more VMs to your pool, using a traffic balancer to distribute workloads to newly started instances.

Deciding which type of expansion you need (or need to plan for) is a designer's decision, but it has to be underpinned by an understanding of market conditions, and that's not an IT-sector job at all. Plenty of hosting

ABOVE Don't expect to swap your old system for the cloud at the flick of a switch

NO ALARMS AND NO SURPRISES



I've no shortage of pub stories about IT managers coming into work on a Monday morning and finding they've no cloud platform to log in to because the cloud provider was hit by a meteorite, or some other disaster, and they didn't plan ahead. Such cautionary tales can be valuable, not to mention entertaining. But it's probably more productive to look at how successful "cloud people" manage to sidestep such disasters.

Perhaps the most important habit is that of engineering soft landings. When I look back over some of the cloud migration projects I've seen, I'm put in mind of a cat climbing an apple tree, with a clear ambition ahead but no idea how it might get down again. When the project reaches the appropriate stage, it is imagined, there will be a glorious big-bang switchover, in which the old service winks out of existence, to be fully and permanently replaced by a shiny new virtual reality. I hardly need to tell you how most such visions play out.

Smart architects know that rollback is not a dirty word. I've known many Exchange administrators running two complete VMs in parallel, one live and another with, perhaps, the next release, so they can hop across to the new system when ready and, crucially, hop just as lightly back again when needed. In time you reach a stage where you know the new system is ready for production – because you've been using it without issue for the past several months.

companies make a great fuss about scalability, but can offer little or no help when it comes to turning your graphs of transactions per minute into practical instructions that tell the cloud orchestrator when to shut down your most lightly loaded VMs.

Getting the scale wrong is an embarrassment, but it's not hard to fix. Even in the worst case all it really requires is a bit of monitoring to see when you're overloading or wasting resources, and a corresponding adjustment to your orchestration details (and associated billing details). However, when businesses go into cloud projects without recognising the significance of scale, that makes me wonder what other important aspects of life in the cloud may have been overlooked.

Mistake 5
Misunderstanding storage

I mentioned above the business whose servers were 100% full on day one of the contract; storage can be an absolute project-killer when it comes to cloud, but it can be tricky to account for.

The key is that absolutely everything you do in a cloud platform counts as "on demand" – and the more you use, the more your monthly cloud bill is going to be. This tends to inspire project managers to aim for the minimum possible storage, but this is often a false economy. For example, it's not unknown for virtual servers to run fine all day, then run out of storage space when the auto-backup service kicks in – using your cloud disk to assemble temporary packages, which then download over your cloud connection (charged in the hosting centre style, by bytes moved not months occupied).

The outcome might be a failed backup job – cause for alarm in anybody's book. Or the truth might come to light only once the bills for the unplanned overage arrive, leading to impressive explosions from the finance director and unnecessary bad blood inside the project team.

Fail early, fail often

I don't want to give the impression that the world of cloud is a fundamentally risky place. Part of what makes the cloud so revolutionary is the freedom it gives you – including the freedom to make mistakes. You can very quickly and cheaply fire up a scratch machine and throw together a rough initial model for your new web platform; if it has a few issues, never mind, just start work on mark two.

Indeed, I'd say this is the best way to make a success of the cloud. Prototyping may not previously have been a major part of your processes, and probably for good practical reasons, but it's something you can do much more easily in a cloud environment than you ever could in a cramped, noisy and above all resource-limited server room. Setup time is measurable in hours, rather than the half-year of provisioning that used to be common in big enterprise networks, and it's cheaper to iterate through 20 cloud-hosted VMs and architectures than it is to buy one large-enough desk-side box for the summer intern.

"Part of what makes the cloud so revolutionary is the freedom it gives you – including the freedom to make mistakes"

My recommendation is for project plans to include at least three stopping-off points for feedback on prototypes. This keeps things on track, and helps uncover unanticipated hurdles and opportunities. Perhaps even more importantly, though, it embeds the idea that not hitting the nail on the head first time isn't something to be afraid or ashamed of. On the contrary, having a long history of trying and failing in the cloud means you know what works for you and what doesn't, and that's a much better place to be in than trusting some eager external developer assuring you it will all be fine. The idea of rapid and even sloppy development may not be comfortable for senior management, which is why so many stand-out cloud projects are created by junior maverick types. But cloud failure isn't a sign that you're getting it wrong; it's the start of the process of getting it right. ●

Phygital convergence

The real and virtual worlds don't have to be two separate domains. Steve Cassidy crosses the bridge

The word "convergence" gets bandied about a lot – what are we talking about here?
It's true, when techies use the word "convergent" it can mean almost anything. You might conceivably say that Mozilla and the internet "converged" to produce the World Wide Web. Personally I'm more troubled by "phygital", a horrible train crash of a term which really just means something we've all been doing with computers for decades – connecting a digital model in software to a physical thing.

So is this primarily about design and manufacturing?
It can relate to any physical resource or emplacement, such as a threshing machine, an oil tanker or a bridge over an angry river. Think of phygital as attaching a digital sidecar to a real thing – to track, store, expose and process information such as location and composition. It may also present a virtual 3D model, which you can explore and interact with – a potential killer app for those VR headsets that everyone seems to be pushing at the moment. It works at any scale, too: you can zoom in and inspect a virus just as easily as a skyscraper.

I see the value in that, but it doesn't sound exactly new. Why are we talking about it now?
One big reason is that, as I say, VR is becoming mainstream. Ten years ago, virtually exploring a digital twin of a physical environment would have required a huge investment in specialist hardware and software. Today there are multiple platforms that can do it for a few thousand quid.

More processing power is also available, whether locally or via edge computing, while cheap drones make it much easier to survey and build digital facsimiles of physical sites.

Okay, I see how the digital side has come of age. But how does all this connect to the physical reality?
The bridge is the – currently somewhat underappreciated – idea of augmented reality, or AR. This is where the headset superimposes digital content onto the real world, so you can see and explore relevant data in the environment, or visualise changes and constructions that aren't really there. So far AR has been rather overshadowed by immersive VR, but there's huge potential in a smart AR system that can identify what you're looking at and feed you actionable information and insights. While not a true merging of digital and physical worlds, it allows the power of the former to be extended into the latter.

Won't it be costly and time-consuming to create digital duplicates of all our facilities?
As autonomous drones, AR frameworks, IoT sensors and good old AI all continue to mature, it's getting ever quicker and easier to generate a virtual replica of a given system, vehicle or building. For a preview of what's coming with this technology, have a play with Google Lens on your phone: it can already pick up and make sense of a remarkable amount of information just from your camera. Connect a system like that to your own sensors and databases and the sky's the limit.

So is investing in phygital convergence a must for all forward-looking businesses?
I wouldn't say that. Most businesses don't want or need to centralise and virtualise every last possible function. Right now, phygital is mostly of interest to the very biggest businesses – those that deal with large-scale systems, and which have the computing resources to work with their digital representations. Then again, depending on your business model, you might want to consider offering a phygital experience to your customers – see below. ●

Consumers lead the way

Many new technologies are first adopted by big businesses, and later trickle down to consumer applications. With phygital convergence the process has gone somewhat in the opposite direction. Since 2016, the *Pokémon Go* mobile game has used a phygital approach to allow users to hunt magical monsters in the real world. And in 2022, Google Maps gained an AR navigation mode that combines a phone camera feed with GPS smarts to show a live view of the world with huge, impossible-to-miss signposts directing users to their destination.

On this page we've focused on how businesses can use a phygital model to better monitor and manage their own physical assets, but they too could benefit from offering phygital services on the consumer side. IKEA's Place and Kreativ apps let furniture shoppers visualise selected items in their own homes; Amazon has long offered a similar app that lets the user insert digital representations of items into a live camera view. Even if your business has no internal need for AR, don't write off its potential as a powerful marketing tool.

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

"Windows on ARM is a much more rounded platform. It just needs the CPU horsepower to make it fly"

Could 2024 finally be the year of Windows on ARM? Does a computer need a command line? And why is Jon giving up on his Intel-powered MacBook Pro?

The arrival of Qualcomm Snapdragon X Elite CPUs on Windows laptops intrigues me. Early benchmarks suggest that Qualcomm and Microsoft have really done their homework here, although I'm not at all bothered whether it's better or worse than an M2 Mac of some flavour. The reality is that it must represent a significant leap from the current Intel and AMD laptop CPU offerings. As *PC Pro*'s own testing shows (*see p52*), this seems the case.

Windows on ARM has had a somewhat difficult recent history, despite the fact that Windows NT was designed as a cross-platform operating system. The first version, NT 3.1, shipped on Intel, MIPS and Alpha. PowerPC came along soon after, but never went anywhere, while Intel's i860 build was never released to the public. Subsequently, Intel's Itanium joined the group, and some of the earlier platforms died off. Then came the x64 port, released first on AMD CPUs with Intel following along afterwards, at which point Itanium rightly gained the nickname of "Itanic" and sank without trace.

All of which left x64 as the only Windows platform through this millennium – except for the rather mixed story of Windows on ARM.

Back when Windows 8 launched, with its entirely new user interface and touch- and pen-oriented design, Microsoft launched an ARM CPU-powered tablet called Surface RT. It was progressive and interesting for 2011, but came with a whole host of limitations. First, it only ran ARM code – there was no capability for it to cross-compile Intel to ARM. That meant all apps had to be ported by the developers for the RT platform, but small sales equalled little developer interest, which then led to even smaller sales of the Surface RT.

It wasn't helped by the poor quality of the Windows Store for distributing apps, nor, as I remember it, the insistence that you couldn't just port your code over. It had to be the newer API and tool specification, although this rule didn't apply to the Microsoft Office team who got a free pass for this.

As you would expect, the RT platform bombed – and Microsoft took a near billion-dollar hit on the whole affair.

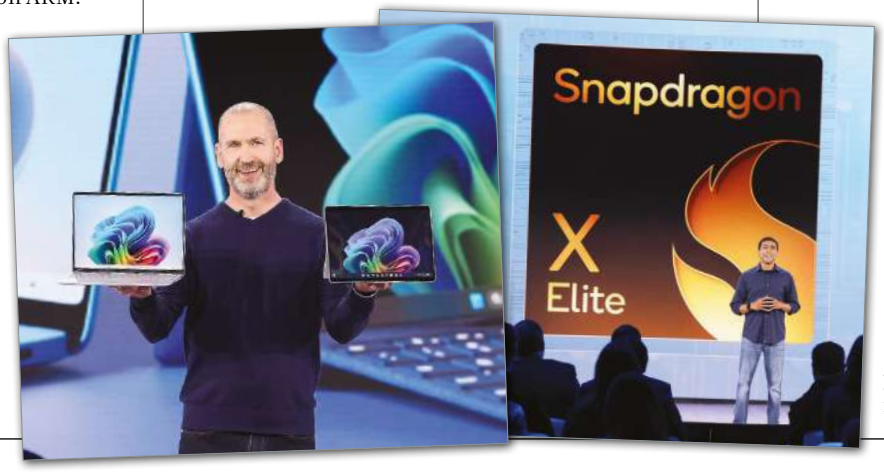
But Microsoft's work with ARM continued, including via the also-doomed Windows Phone platform. There have been various versions of Windows for ARM in the subsequent years, mostly based round the Surface Pro X platform with its Microsoft-designed SQ1 and SQ2 CPUs, which were built by Qualcomm. Although the Surface Pro X has its fans, I never liked its poor performance on the Intel-to-ARM code translator and limited range of native applications.

This has improved as the work continued, and now Windows on ARM is certainly a much more rounded platform. It just needed the CPU horsepower to make it fly, and this brings us full circle back to the new Qualcomm Snapdragon X Elite and my opening comment about it needing to be more powerful than existing x86 laptops.

And, just like Apple, there are signs the X Elite could make its way into desktop PCs: Qualcomm has just announced a Snapdragon Dev Kit for Windows based on the CPU. Rather like the earlier Microsoft Volterra platform, it's aimed at developers wanting to port their code to ARM but not limited to a laptop platform. Although I'm sure the new laptops will be a success, I think one mark of really arriving with a bang will be when the usual hardware vendors like Dell launch desktop units running the ARM CPU. At that point, the failures of RT and Surface X can be forgotten, and Microsoft can fondly remember the Alpha, MIPS, PowerPC history of this cross-platform architecture with pride.

Jon is the MD of an IT consultancy that specialises in testing and deploying kit
@jonhoneyball

"Itanium rightly gained the nickname of 'Itanic' and sank without trace"



BELOW Qualcomm's Snapdragon X Elite CPUs are coming to Windows laptops

M4 iPad Pro capabilities

The arrival of the M4 CPU in the new iPad Pro was quite unexpected. I was expecting a move to M3, to bring it into sync with the other platforms. But M4 is apparently being built on the second-generation TSMC production facility, and the iPad Pro is an ideal platform for the slow rollout, as yields increase.

Jon Honeyball
Opinion on Windows, Apple and everything in between – p108

Lee Grant
Tales from the front line of computer repair – p111

Olivia Whitcroft
Lawyer Olivia offers legal advice for the tech industry – p116

Davey Winder
Keeping small businesses safe since 1997 – p118

Steve Cassidy
The wider vision on cloud and infrastructure – p122

I confess my wallet began quivering uncontrollably so I had to buy one of the 13in models with the larger CPU. It was inevitable, since my iPad Pro is the older M1 version. Apple isn't screaming about this, but the 1TB and 2TB storage versions have a higher count of CPU cores, doubtless caused by TSMC "binning" the production line output and keeping the best for the more expensive units. It's also worth noting that these pack 16GB of core RAM, not the 8GB of the lesser storage versions, so a real power user will definitely want both the full core count and more memory.

The screen slaps you between the eyes: a dual-layer OLED panel with deep blacks and searing whites in HDR mode. The new Pencil Pro is a delight, and little touches such as the fake generated drop shadow showing the shape of the selected tool made me squeal.

But does anyone need it? Let's put aside the broad use of the term "need" for a moment; there's nothing wrong with wanting The New Shiny. And the 13in M4 iPad Pro is an absolute statement of incredible engineering, alongside the new keyboard.

The whole question becomes why buy this when there are two obvious alternatives. For the same money, you can buy a powerful laptop, either from Apple or one running Windows. Surely the limitations of iPadOS are so significant than this is a case of "great hardware, shame about the OS"?

I think that is entirely the wrong approach to take. Not every device needs a command line. That sort of generalised operating system is entirely right and proper for some use cases, and there are times when only a command line will do, but everything I've done in the past 48 hours on the MacBook Air I'm using could have been done on the iPad Pro.

And that's one of the most crucial points – I really hope Apple doesn't add touch to macOS to try to make it more iPad-like. And I don't want macOS on an iPad, thanks. Otherwise, you end up with the sort of mess you see on Windows 11.

Then we come to speed. The new iPad Pro's performance running professional-grade software is simply ridiculous, and makes my M1 iPad Pro feel ancient by comparison. But don't rush: if your workload is based around office documents and browser windows, then the capabilities of the CPU, graphics and screen will be entirely lost on you, irrespective of how lovely they are.

That's where the 13in iPad Air comes in. You want a bigger screen and a more expansive keyboard option, but don't want to be forced into spending four figures on the Pro? The Air 13in is the ideal solution and might be the ultimate tool for daily workloads. Especially for students. I'd certainly consider one for a college student as the best choice for all-round operation for someone who is neither a Pro-grade power user, nor someone who needs a command line.

Migrating my laptop

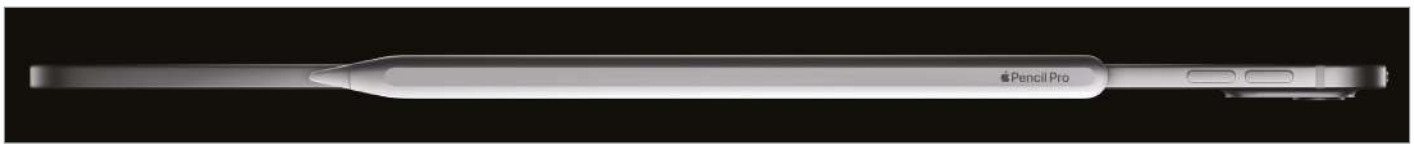
The time had come to move off my trusty 2019 15in MacBook Pro. It was the last of the Intel versions, running an 8-core Intel Core i9 processor, stuffed with 64GB of RAM and a 2TB SSD. It's still eminently usable, so why make the move if it isn't broken? First, it's possible that the Intel support from Apple for macOS will be coming to an end soon. We are now at the M3 version of the ARM-based processors, with M4 just around the corner. That doesn't diminish the Intel MacBook's usefulness, of course, but it's a big lump to haul around. It will be retired to quasi-desktop use at home.

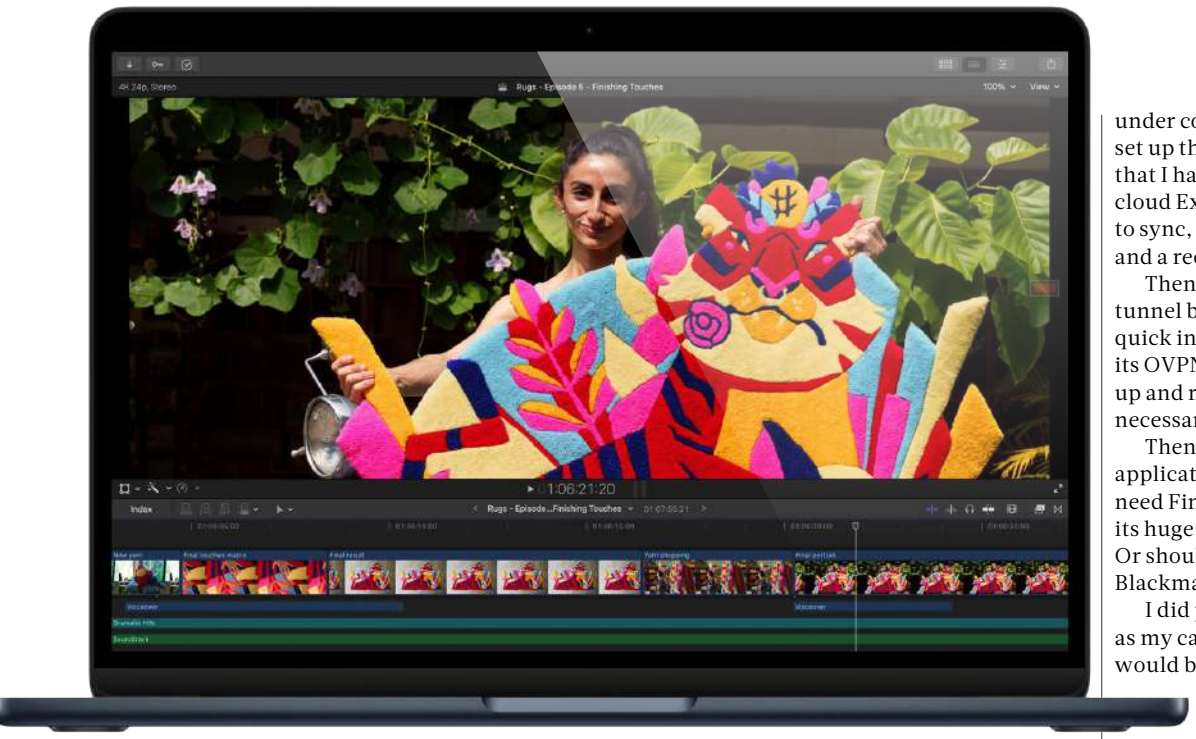
A MacBook Air is a much more sensible and truly portable computer. I have an M2 MacBook Air with 24GB of RAM and a 1TB SSD, and the smaller form factor is quite important when hauling it around, especially in the bags that go inside my motorbike panniers. Tonight I'm off to stay next to St Pancras station, because I have to be in the terminal at 5am for the 7am train to Paris for a work trip. The MacBook Pro is just too big for this trip, and the rest of the

ABOVE The dual-layer OLED panel slaps you right between the eyes

"The 13in M4 iPad Pro is an absolute statement of incredible engineering"

BELOW Apple's new Pencil Pro is a delight, albeit an expensive one





week while I am away. The Air is perfect. So this immediate size difference has kicked off a change that is somewhat overdue.

The Air is also being retired from its initial testing role for testing Wi-Fi units. It doesn't support 6GHz, nor Wi-Fi 7, aka 802.11be (although that's somewhat irrelevant at the moment given how those bases are rapidly running through firmware updates as they attempt to make the standard stable and usable). So an M3 Air is on the way for that role, leaving the M2 Air available to be pressed into service as my new portable laptop.

Moving from one Mac to another is almost ridiculously easy, doubtless helped by Apple's small selection of hardware that it builds itself. It would be an almost impossible task to move between Windows machines from different vendors, for example, where the plug-and-play driver storm can look quite worrying at times.

Doing the migration is simply a matter of running Migration Assistant on each laptop, choosing the direction of the move, and then sitting back and watching it all happen. I've done this many times before, and it's almost miraculous in its capabilities.

Or so I thought until I tried it moving from the Intel MacBook Pro to the ARM M2 MacBook Air. Although it worked, and everything was in place, it was clear that the code base change was not without its issues. And that, as I suspected, my older MacBook Pro had some five years' worth of crud lurking around in the inner workings of the operating system. It has had a hard life, and although not in any way comparable to the "Windows Rot" that can sometimes be observed on well-used Windows computers, it's clear there were things there that I didn't really want.

So I decided to start again from scratch. I booted the Air into recovery mode, told it to vape the disk and then to pull down the OS and updates from the internet and recovery partition. A fresh installation was done, after which it was a matter of rebuilding my laptop world on the Air. This wasn't hard: Office 365 brought my Microsoft platform with it, Bitwarden gave me access to all my passwords and 2FA keys (this required using the hardware key to unlock it on its first run). A browser or two followed, along with an essential array of plugins to keep adverts and bots under control. Finally, it was time to set up the five main email accounts that I have running in Office 365 cloud Exchange server, and allow this to sync, pulling down the messages and a recent selection of attachments.

Then I realised that I had no VPN tunnel back into the lab network, so a quick install of OpenVPN along with its OVPN configuration file got that up and running. This would be necessary for the trip to Paris.

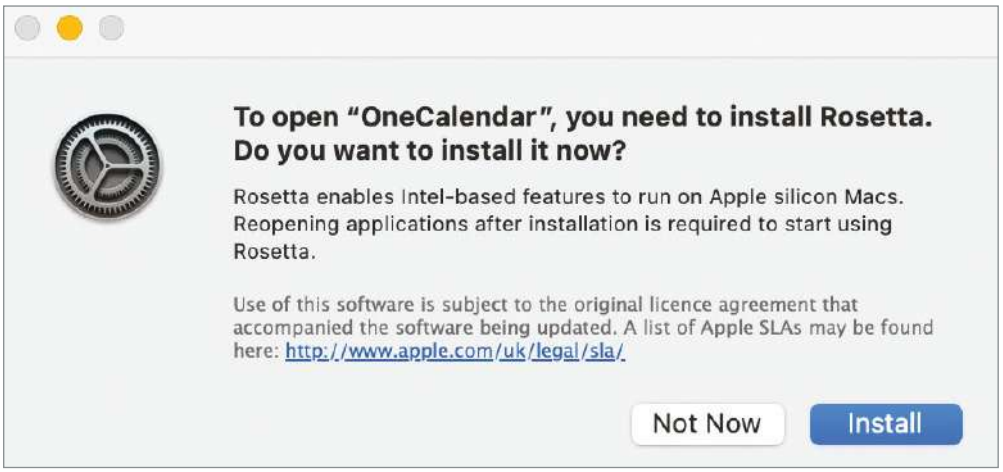
Then I had to decide which key applications to install. Did I really need Final Cut Pro and Logic Pro with its huge library of music samples? Or should I just go all in with Blackmagic DaVinci Resolve?

I did pause with a few apps such as my calendaring tool, because this would be the first Intel-based app that I was installing. The Air asked if I wanted to install Rosetta, Apple's Intel-to-ARM code translator. I said no. So far, I have resisted doing this, wanting to keep the platform ARM-only and to banish the Intel code base from my daily working laptop. After all, the whole point of initiating this migration was to get away from the Intel code base, so it seemed somewhat purer and more honest to stick to ARM throughout. It hasn't been an issue, but if you do put Rosetta onto an M-based ARM CPU Mac, then check out the "Kind" column in the CPU panel on Activity Monitor, which will list each process as either Apple or Intel.

Am I pleased with the migration? So far, yes, although I'll know more after its first road trip. The older Intel MacBook Pro is like a well-worn set of boots – it has everything I need, but would probably benefit from a clean down, reset and reinstall. But, just like those boots, it's probably better to let it be, and keep going until the plug gets pulled by Apple.

ABOVE The M2 MacBook Air is a truly portable computer

"My older MacBook Pro had some five years' worth of crud lurking around"



BELOW I didn't install Rosetta, as I wanted to keep things ARM-only

MS-DOS source code available

Microsoft has released the source code to MS-DOS 4.0 onto GitHub (**tinyurl.com/359msdos**). You can download it, compile it and then install it onto a suitably ancient computer should you wish. It's of historical value, but certainly not something I would want to run now. Indeed, I didn't want to run it when it was new.

What's more, MS-DOS 4.0 wasn't actually the one we remember from back then – that was MS-DOS 4.01. The 4.0 release was a special one from 1986 with some altered features such as multitasking functionality. This was somewhat limited because it couldn't address RAM above the 640KB limit, nor did it use protected mode on the CPU.

Nevertheless, it's an interesting, if deeply nerdy, dive into operating system history. Although it has no functional use at all, and you need the right tools from that era to be able to compile and build the source code tree, it's still an important historical record. It would be nice to think that other operating systems from Microsoft will be open-sourced in the same way, but things do get more complex. That can be because chunks of code might have been licensed in from third parties, and this doesn't allow for public distribution, even all these years later.

There are various leaks of code bases around on the internet should you care to hunt, but I can't validate their quality or accuracy.

I've been looking around for Windows NT4 with the NeXT OpenStep release that was made available for NT4. I ran this at the time and was quite boggled by how it brought Display PostScript and the NeXT development platform onto NT4. In some ways, this was my favourite version of NT of all time. It even ranks alongside NT for Digital Alpha, with its frankly amazing Intel to Alpha cross compiler technology. I really wish I had my Alpha computer, now long gone. And a build of NT4 with OpenStep running in a virtual machine.

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LEE GRANT

"As many *PC Pro* readers will attest, the danger to becoming a fixer is that it becomes addictive"

While a Microsoft Retail Pro desecrates a beatified pensioner, two genuine experts illuminate positive sustainable practices at Back Market

Microsoft's ExpertZone is a retailer's resource packed with interactive training elements. It's all here: Surface, Windows, Xbox, Azure, all tailored to enhance the retail experience in order to sell more product.

The last time I mentioned ExpertZone (*see issue 328, p114*), I used approved Microsoft sales tactics while two people attempted to acquire a laptop (for no cost) from our shop to flog it for vast profit. Who could foresee that stealing things to make vast profits would become the business model that launched AI into the mainstream?

Today, Microsoft is keen for its ExpertZone trainees to help claw back some of the $10 billion it sunk into OpenAI. I took the Copilot 2024–25 ExpertClass as I wanted to discover how I should "officially" sell AI to my customers.

The approved Copilot sales technique

A man led the training video, peering down the lens and frothing with enthusiasm about how Copilot will transform the lives of my customers. Sadly, I was utterly distracted by his silky long hair and uncanny resemblance to Dave Grohl from the Foo Fighters, but I regained my composure to absorb his top three Copilot demonstrations with which to dazzle the good folk of Yorkshire.

Dave's strong opener was making a greetings card with Microsoft Designer. There are a few ways of accessing this tool, but I've found that going directly to **designer.microsoft.com** gives the best experience.

Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
@userfriendlypc

"I immediately had concerns about using this sale-scenario on a pensioner from Batley"

BELOW Mother Teresa rendered in mashed potato? Thanks, Microsoft

Funster-Lee recommends having a play with Designer as it's accessible and impressive. Environmentalist-Lee says that if you realised how many of the Earth's resources will be used to fuel and cool the data centre that will generate your hilarious picture of Mother Teresa rendered in mashed potato, then you probably wouldn't bother.

Dave's next suggestion was to create a middle-grade lesson plan, and I immediately had concerns about using this sale-scenario on a pensioner from Batley. Dave explained that Copilot is fabulous for teachers who are running classes without a lesson plan – and that may be true – but I haven't got a queue of under-prepared teachers gagging to buy laptops. That said, Microsoft is pushing AI to the education sector via its Reimagine Education programme (**tinyurl.com/359reimagine**), and some of the most eye-catching initiatives I've spotted are resources to combine Copilot and *Minecraft* into teaching aids (**tinyurl.com/359minecraft**), including the difficult-to-deliver topic of coding.

From a retailer's perspective, Dave's last suggestion of allowing Copilot to generate daily fitness routines has the semblance of a desperate idea scribbled on the back of a sodden beer mat.

Next, we moved to a case study about Heidi, who likes to write to distant family via email. As an ExpertZone Retail Pro, I'm meant to dazzle Heidi with a way to use Copilot to draft the emails she loves to write. Poor Heidi. Personally, I love training as there's always something to learn, and that includes learning that currently, at least, there's nothing to learn.

Behind the scenes at Back Market

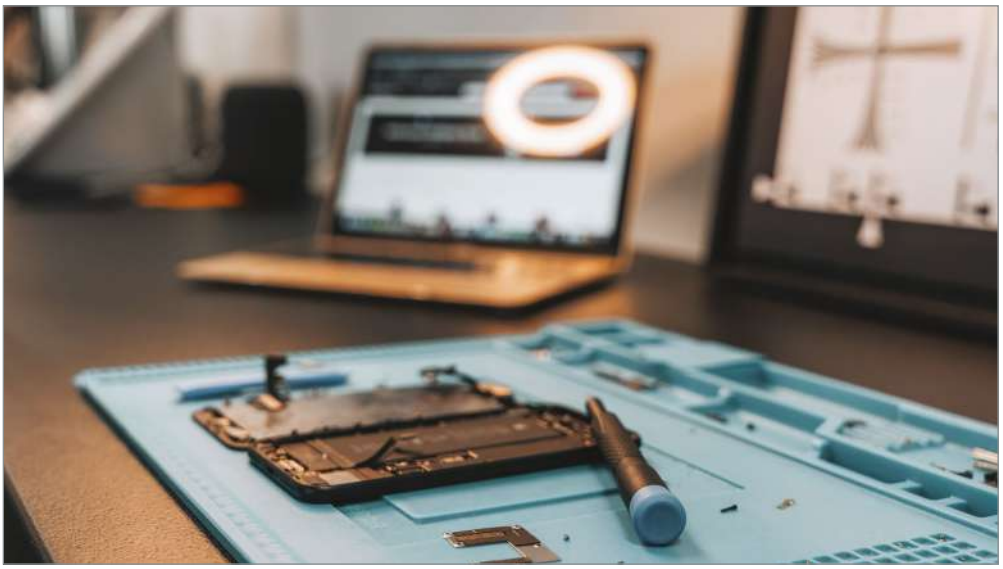
Back Market is rapidly becoming one of the go-to names in refurbished tech. Earlier this year, I was fortunate enough to interview its UK general manager Katy Medlock (*see issue 356, p34*), and I found her passion for the practicalities and environmental necessity of refurbishing both refreshing and honest.

A few weeks ago, I had the immense pleasure of meeting two people who help drive the environmental vision of Back Market's operation. Camille Richard, Back Market's head of sustainability, told me why it is much more than a retail marketplace. "The idea was about trying to make a difference in the tech industry," she said. "Our consumption of tech is destroying the planet and the solution was repair and refurbishment, but there was a trust gap."

It's true that buying refurbished products has been perceived as risky, and this has been exacerbated by the fragility and short life cycle of modern tech. For Back Market to succeed, it needed to close the trust gap. "The idea was pretty simple," said Camille. "Close the gap by offering the same experience you have when buying new. Impact reduction was really the origin of the company. It was about encouraging customers to reduce their own impact easily."

Back Market's strategy appears to be working. Camille reported that although price remains the driver for sales, around 25% of customers state a desire to reduce their environmental impact. Prior to Back Market, Camille worked for the Suez group (**suez.co.uk**), which works with businesses and local authorities to embrace the circular economy, so is fully aware of what happens to tech that can't be refurbed or repaired. "We need to stop seeing waste as waste but as a potential new resource," she said. "Less than 20% of waste is recycled and it's how we make this industry scale to reduce the costs of treatment."

At Back Market, Camille has seen the latest advancements in tech recycling. "I visited a new waste recycling facility in the US. It was amazing to see the value they got from the waste people were throwing away. A lot of the devices, they're selling to a refurbisher. The rest of the e-waste is optically sorted using density and weight detection to separate aluminium, copper and things like that. The rest they shred, sending it to partners; 40% of this is precious metal, which can create secondary raw materials to produce other products. Plastic powder is used to make benches and things like that. We need this industry to develop, to extract this value from waste."



Working alongside Camille is Kewin Charron, senior lead refurbishment operations manager. He oversees Back Market's Innovation Lab, a small team of experts who dissect tech products to help their sellers and customers. "We're working on three pillars," he told me. "The first is quality control. We perform mystery shopping all day long and all week long, ordering from sellers to ensure they comply with our quality charter. We disassemble devices and test them, checking that everything is properly cleaned and that the parts used are good enough. We're trying to identify issues related to a specific seller or a specific model."

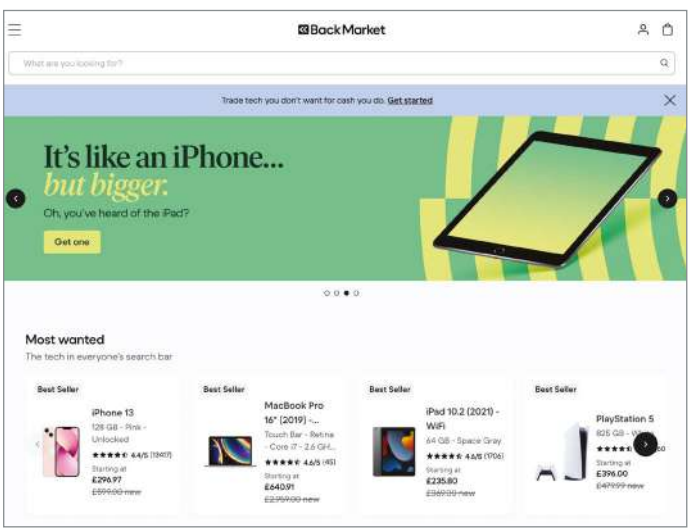
ABOVE Back Market's Innovation Lab dissects tech products to help sellers and customers

"We need to stop seeing waste as waste but as a potential new resource"

This hands-on QC is critical to ensuring a satisfactory customer experience, but Kewin points out that Back Market's efforts may go unseen by its buyers. "Our second pillar is helping the sellers. We find stuff with them and engage with them to help them grow a category or tackle issues around testing and refurbishment practices."

That Back Market values such collaboration between itself and its sellers speaks volumes about how much it understands the complexities of repair and refurb. Entities such as iFixit succeed (largely) because of the community-led approach to repairing the unrepairable, and Back Market has taken this concept to a retail model.

Kewin explained that its knowledge is also a resource to be maximised. "The third pillar is to spread the knowledge internally, so we're helping the customer care team, building FAQ articles and solutions for customers to handle minor software issues by themselves. We're also writing articles and tips for everyone, looking at what's happening in real life and what customers are experiencing. Trying to find the solutions and help everyone."



BELOW Back Market is one of the go-to names in tech refurb

Kewin knows too well how a working product can be rendered useless overnight, especially with one of Back Market's biggest lines, iPhones. "When it comes to compatible batteries, you have to do some stuff in order to get rid of warning messages. It's parts pairing of the batteries. iOS 17.4 blocked it, but we worked with two sellers and found a bypass to help all sellers do their repairs properly." Like all repairers, Kewin and his team found

this solution by trial and error and using their wealth of experience. The encouraging news is that Oregon and Colorado's new Right To Repair law (**tinyurl.com/359colorado**) outlaw parts pairing on devices manufactured after 1 January 2025, so this sort of nonsense should slowly fade away.

It's refreshing to see that such a large company recognises the everyday challenges of repair and refurbishment, and Camille revealed Back Market is keen to share its wealth of knowledge with a wider audience. "We have a philanthropy programme at Back Market, and one of our projects is to support a training centre in Paris. We are talking about how we can help with knowledge, how we can help with devices and these kinds of things. It's important to know that the refurbishment industry is craving for people to come to work with them."

As our time was brief, I asked Camille to explain her vision for the future of Back Market and refurbishment. "I would like sustainability to be our main point of differentiation. We are trying to make this world less complicated when it comes to tech, so we need to be better at the way we educate people on the impact of tech. If we're recognised as a company that shows the world that you can be profitable and sustainable at the same time, I would be really, really happy."

SimpleHuman kindness

Back Market is correct. If we're ever going to achieve a circular economy model for electronics, part of the solution is training an army of repair-capable recruits who are inspired by the ongoing positive changes being made around the world in terms of eco-design and right-to-repair.

As many *PC Pro* readers will attest, the real danger to becoming a fixer is that it becomes addictive. Fixers know that not everything can be repaired, but that doesn't stop us spending hours on futile failures. One Saturday morning at the beginning of the year, I stood in an industrial workshop hoping that the metal fabricator could re-weld the broken bearing mount on our 20-year-old tumble dryer. I can't tell the whole sorry story without weeping, but the denouement involves Mrs Grant dispatching me to collect the new one she'd ordered online.

The losses are tough, but the wins are worth it. The 500GB SATA drive inside our trusty Humax PVR died and, thanks to some repair guides written by other fixers, I learned that the Humax's OS resides on chip. I pulled a 1TB replacement from my sizeable store of redundant drives, and the Humax was fixed and upgraded within 15 minutes.

Getting spare parts is a perennial hurdle, but from time to time a manufacturer just excels. SimpleHuman (**simplehuman.co.uk**) is a globally renowned manufacturer of "tools for efficient living". We have one of its pedal bins in our kitchen which we estimate is around 17 years old, so it was no surprise that the slow-close mechanism failed. This feature also provided sound dampening; without it, the thing sounded like Keith Moon drumming out aggression. SimpleHuman not only had the part, but supplied it for free with fitting instructions. It values repair as it increases its products' longevity, which reduces the environmental impact. It's (almost) that simple.

ABOVE **The Humax PVR was fixed within 15 minutes thanks to fixers' online guides**

Microsoft vs the Warrior Queen

Some manufacturers understand repair, while others ignore it. Microsoft's ExpertZone has 30 courses about AI but none about repair. There are two courses promoting the sustainability benefits of a Surface, but the furious Surface owner whose soldered-on RAM has blown within 18 months won't be appeased by being reminded that his stylus used to be a water bottle.

The thing I love about ExpertZone is that it contains some fabulous advice, but much of it written by people who have never sold anything in their lives. To get my gold badge, I had to pass Windows 11 Home Accreditation, which honed my sales techniques down to: (1) What do you want? (2) Do you use Office? (3) Wanna play Xbox? (4) We want AI to run your life. I'd pay handsomely to watch the course curator deal with Boudica.

"Mrs Grant mentioned AI, but here in Yorkshire it's a form of friendly greeting"

BELOW **I am now the proud owner of an ExpertZone gold badge**

Obviously, Boudica isn't the customer's real name, but it defines her character and, like her namesake, she's also waged a revolt, not against the Romans, but modernity. Boudica doesn't have the internet and has never been online. She doesn't have an email address, a mobile or even a landline answer-machine. Oddly, she's been a customer from the start, and recently her XP machine exploded and she ordered a replacement. She doesn't drive, so I wrote a letter detailing her preferred metrics of suitability, dimensions and weight (forget RAM or cores).

She asked if we could bring samples of printers to assess (I couldn't) and could we collect, data transfer and install (I could, or rather Mrs Grant could as Boudica will discuss matters with me, but I'm not allowed in her house). I'm sure you've guessed that Boudica uses her PC as a glorified typewriter, and supplying her with a Raspberry Pi would be beyond adequate, but she wants Windows, because she knows Windows.

It will be interesting to see how Windows 11 copes with being offline. We installed LibreOffice as Office 365 habitually goes read-only if it can't dial home. We're aware of customers who use paid-up 365 subscriptions in offline environments but resort to "illegal" cracks to keep it from crying. If anyone from ExpertZone is reading, Mrs Grant mentioned AI to Boudica, but here in Yorkshire it's just another form of friendly greeting.

...and finally

Now I need to give you a bad-language-ahead warning for this link, but it's a record of an event that was so improbable that some may think that generative AI is at play. Take a moment to watch the real Dave Grohl in action at **tinyurl.com/359realdave**.

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OLIVIA WHITCROFT

"Even those who created the rules were finding it difficult to comply with them"

If your company transfers any data to the US, or other countries, then you need to stay on top of the legal rules – or risk huge fines

Woah! It's been over a year since I last updated you on international data transfers.

Those were the days when compliant transfers of personal data to the US seemed impossible. In 2020, the EU-US Privacy Shield was declared invalid, and there began the requirement to undertake transfer risk assessments (TRAs) when using contractual solutions to send data to the US (and other countries). It got worse from there, as it seemed supervisory authorities were not taking a laissez-faire approach to enforcement of the new requirements; for example, the Austrian and French authorities' action against websites using Google Analytics, as covered in my article in issue 343 of *PC Pro*.

In 2023, Meta Ireland was fined €1.2 billion by the Irish Data Protection Commission – the largest GDPR fine ever – for unlawful transfers of personal data to the US. Despite Meta putting extensive supplementary data protection measures in place to address the risks, these were found to be insufficient.

Organisations couldn't escape the risks by relying on well-known platforms. In March 2024, the European Data Protection Supervisor found that the European Commission's use of Microsoft 365 since 2021 infringed data protection law due to a failure to implement appropriate safeguards for transfers outside the EU (including to the US). And the EU Commission wrote the GDPR. So it seems even those who created the rules were finding it difficult to comply with them.

Would transfers to the US ever be lawful again?

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"The new framework could be an even shorter-lived solution than its predecessor"

Yes, they would...

In 2022, the EU Commission and the US government discussed a new EU-US data privacy framework, and the US President signed an executive order to introduce protections into US law regarding surveillance activities. As from July 2023, EU organisations have been able to transfer personal data to US organisations signed up to the now-approved framework, without the need for other transfer safeguards.

This was followed by a UK extension to the framework (known as the UK-US Data Bridge). Since 12 October 2023, UK organisations can make transfers to US organisations signed up to the Data Bridge, again without additional transfer safeguards.

You can check whether US organisations are self-certified with these regimes at **tinyurl.com/359usdpf**.

Even better, transfers made on this basis don't require exporters to do a TRA, as the EU Commission and UK government have already assessed the risks as part of deciding that the framework is adequate.

...but maybe not for long

Alas, it's not all good news for exporters. Max Schrems is the pioneer of striking out previous EU-US data transfer mechanisms, and the chairman of noyb (**noyb.eu**), a privacy rights organisation. I was fortunate to hear him speak at a conference in September 2023. He took us through some apparent flaws with the new framework and US legal measures. Concerns include that the meaning of the word "proportionate" (for US government surveillance) is not aligned with the EU concept of proportionality, and problems with the new redress mechanism for individuals. It's no secret that noyb has plans to challenge the framework.

He's not the only one spotting problems. In September 2023, the UK ICO published a statutory Opinion, identifying four areas of the UK-US Data Bridge that could pose risks to UK data subjects. First, the definition of "sensitive information" (and therefore the protections applied to such information) doesn't cover biometric, genetic, sexual orientation or criminal offence data. Where included in the transfer, UK exporters should actively specify this additional data as sensitive. It is also unclear how spent criminal convictions are protected, and certain rights for individuals – to withdraw consent, to erasure of data, and to obtain human review of automated decisions – are missing. If relevant in context, UK exporters may want to build in additional protective measures in these areas.

In the same month, Philippe Latombe (a French MP, though acting as a private citizen) applied to the Court of Justice of the European Union (CJEU) for annulment of the adequacy decision for the EU-US framework. His challenge is on several grounds, including inadequacy of privacy guarantees for bulk collection of data, lack of effective remedies for individuals, no framework for automated decision-making, and only vague security safeguards. An application for interim relief (to suspend the adequacy decision) was refused by the CJEU in October 2023, but the main case appears to be ongoing at time of writing.

So the new framework could be an even shorter-lived solution than its predecessor, the Privacy Shield (which lasted four years).

TRA options

Back in March 2023, I was talking about the ICO's new TRA tool. When using this tool, organisations need to carry out an investigation into the laws and practices of the recipient country, unless the data being transferred is all low risk in nature. Although arguably easier to navigate than the EU approach to TRAs (which

BELOW Meta Ireland was hit by the largest ever GDPR fine for unlawful transfers

was the only other ICO-approved option at the time), organisations still reacted with incredulity at the complex task expected of them.

In December 2023, the ICO introduced a new "Option 3" for TRAs, as an alternative to using the ICO tool or EU guidance. It's currently relevant only for transfers to the US, though this is a good country to be relevant for, given the popularity of US transfers.

Option 3 may be used when a TRA is needed because the US recipient is *not* signed up to the UK-US Data Bridge. However, it relies on the UK government's analysis of US laws (in particular, surveillance laws) when assessing the Data Bridge. If you're entering into the UK international data transfer agreement (IDTA) with a US recipient (or putting in place other approved safeguards), you can rely on this analysis for your TRA, without needing to conduct your own review of US laws, as may otherwise be required under the ICO tool. I was disappointed not to hear whoops of joy at this news at a recent training session I gave. But perhaps it's because I'd put all the delegates on mute.

Looking forward, the ongoing validity of Option 3 could go hand in hand with the validity of the Data Bridge. If US legal protections central to the adequacy of the Data Bridge are found to be inadequate after all, surely these could lead to unaddressed risks within the TRA?

Responsibility for TRAs

I had an interesting discussion about how restructuring a supply chain can change responsibility for TRAs. In accordance with UK guidance, the party that is "initiating and agreeing" the transfer must comply with the transfer rules. Let's say delivery of a service involves two providers; one in the UK and one in the US. If you appoint both providers separately, and then send (or instruct your UK provider to send) data to the US provider, you are responsible for the transfer. On the other hand, if you appoint the UK provider to provide the full service, and it partially sub-contracts to the US provider, then the UK provider is responsible for the transfer of data to the US provider for this purpose.

But just because you aren't then responsible for transfer rules and TRAs doesn't mean that the risks of the transfer don't exist, nor that you should simply ignore them. All organisations need to understand their data flows and carry out appropriate checks on providers. This includes checking a provider has carried out an appropriate TRA where needed. Nevertheless, it may still be appealing that the provider is investigating the laws of the country of transfer, rather than you!

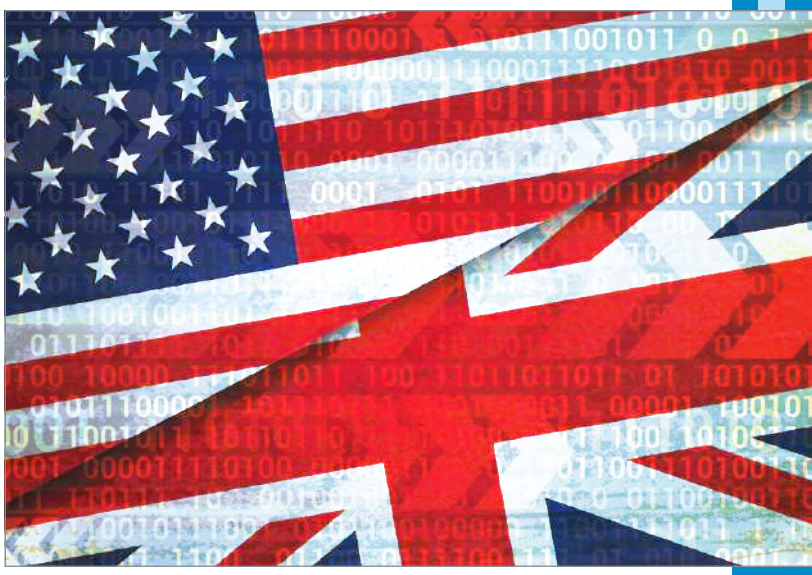
Derogations

There are a number of exceptions (or derogations) to the rules on international data transfers. I was brainstorming with my client whether or not a derogation could be used for sending its customer data to a technology provider in the US.

One possible derogation is where the transfer is necessary for performance of a contract between the customer and the controller (in this case, my client). The ICO's interpretation of a transfer being "necessary" is where it is objectively necessary and proportionate for the stated purpose (in this case to perform the contract), and not just necessary as part of your chosen methods.

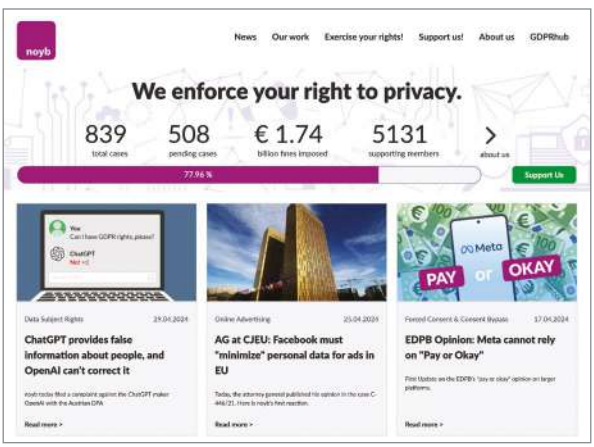
It's often difficult to argue that it's necessary to transfer data to an overseas provider, where the core purpose of the contract could still be performed without the transfer. For example, if you sell products to UK consumers, it's unlikely to be necessary for you to transfer customer data to an overseas data storage provider. You may need to collect and store customer details in order to fulfil orders, but you *could* use a UK provider or store them in-house. Appointing the overseas provider is simply how you've chosen to run your business.

In contrast, UK providers didn't offer functions equivalent to those from my client's US provider (which were core to the customer contract), and my client couldn't provide these functions in-house. So, arguably, the transfer was more likely to be "necessary" for the contract.



ABOVE Data transfers to the US from the UK are still fraught with potential dangers

"It would be sensible for anyone transferring data to the US to think ahead"



BELOW The privacy rights group noyb plans to challenge the new EU-US framework

However, another matter to assess is whether, rather than relying on the exception, it is more proportionate to put in place a safeguard, such as the IDTA. This is likely to be the case for regular, rather than one-off, data transfer arrangements. As regular transfers were proposed here, the IDTA was probably a better approach.

Use of the IDTA triggers the need for a TRA, which may result in residual significant risks being identified for the transfer of particular data to the US (particularly as this pre-dated Option 3 described above). The ICO's TRA tool then suggests looking at whether exceptions apply in relation to significant risk data. So we can go back to considering the contractual necessity derogation. As the IDTA already provides some protection, it's now more proportionate to rely on this exception for regular (and not just one-off) transfers. The same exception we had rejected therefore becomes a more realistic option to complete the TRA and proceed with the transfer.

The saga continues

We're on holiday at the moment, enjoying our hassle-free transfers to the US on the basis of the EU-US framework, UK-US Data Bridge or UK Option 3 for TRAs. But it would be sensible for anyone transferring data to the US to think ahead to what they may do (potentially in a hurry), if the framework is once more struck out. Return data to the UK (or EU)? Restructure your supply chain? Anonymise or reduce the amount of data? Lean more on derogations? Develop your own expertise in assessing risks of US surveillance practices? Or perhaps try to surpass Meta in securing the highest GDPR fine for unlawful transfers?

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DAVEY WINDER

"You should already be on top of the authentication process. If you aren't, then now is the time"

Davey puts on his best Dalek voice and shouts "Authenticate, authenticate, authenticate" as he explains why you should check your DMARC settings

Last month, I briefly mentioned DMARC when writing about how and why I switched my primary email client from Gmail to Proton Mail. This month, given the amount of activity surrounding email authentication over the past few months from both sides of the cybersecurity fence, I thought I would dive a little deeper.

I suspect – I admit I have no actual statistics to back this up – that most email users have never heard of the Domain-based Message Authentication, Reporting and Conformance (DMARC) security protocol. Why would they? So long as emails are reaching their destination, be that their own inboxes or someone else's, why worry?

Indeed, when Google started to implement new rules relating to the authentication of messages arriving in Gmail inboxes from marketers, spammers and anyone else who might fall into the "bulk sender" category, there was much scratching of heads among those sending me messages asking what the heck was going on. Admittedly, many of the questioning emails I received following a mention of this two months ago (*see issue 357, p118*) mistakenly thought it meant that their emails were suddenly going to vanish into the ether if the mysterious DMARC wasn't activated.

I blame myself for not properly explaining myself then, which I aim to correct now.

What's happening is that Google will simply require bulk senders – from the Gmail perspective, that means anyone sending at least 5,000 messages in a 24-hour period to Gmail accounts – to properly authenticate their emails. This is regardless of how many subdomains are used to do so, as the primary email domain is used to calculate the totals. Hit that bulk sender limit once and forever more you will be a bulk sender as far as Google is concerned. And that's a good thing. Why so? Because email domain authentication has long been something used and abused by spammers, scammers and other malicious senders.

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"So long as emails are reaching their destination, why worry?"

Not so good is that the new rules apply only to bulk email sent to personal Gmail accounts and not to those sent to Google Workspace accounts, although they do apply to all senders regardless. Yahoo Mail has introduced a similar requirement.

It's early days for all of this, with the rollout of the authentication requirement starting in April when a percentage of non-authenticated traffic was rejected by Google, with the percentage rate gradually increasing over time. As far as I can ascertain, that means, for example, that if 75% of email traffic is authenticated then "a percentage" of the remaining 25% of traffic will be rejected by the Google servers and not arrive in your inbox. All that Google has said, to me at least, is that this rejection rate will increase. This makes more sense than a blanket bouncing of email immediately, while senders get used to the new gradual and progressively more secure regime.

BELOW Google is implementing new policies to fight spam

Oh, I should add that there will also be a requirement for all "commercial or promotional" mail from bulk senders to include a one-click unsubscribe option from the summer as well, but I'm less enthusiastic about having to click any link in a spammy and potentially malicious email.

When I spoke to Google about all this, I was told that it will boost sender-side security as well as increase trust on the Gmail user side of things. "Meeting these requirements should help senders reach those who want their messages more effectively," the Google spokesperson said, "with diminished risk of spoofing and hijacking from bad actors." Diminished, but not exterminated. For example, while such authentication requirements will help reduce general spam, including scattergun phishing campaigns, it won't hit the more dangerous and highly targeted spear-phishing campaigns used by state-sponsored groups and the more organised cybercriminal outfits.

If you have admin control over your own domain and use this for email then you really should already be on top of the authentication process. If you aren't, then now is the time. This means you need to roll your sleeves up with DMARC, but first there's the small matter of getting your hands dirty with Sender Policy Framework (SPF) and DomainKeys Identified Mail (DKIM) records.

SPF enables your mail server to determine if an email that claims to be from a specific domain came from a host that is authorised by that domain admin as per the Domain Name System (DNS) record. It's a simple way of verifying if the email should be accepted or bounced, and helps filter out "from field" spoofing, but it works best used alongside DKIM.

Although similar in destination to SPF, stopping spoofed or unauthorised emails, the route taken is different. DKIM uses a digital signature, a text string header (or hash value if you prefer) attached to the email message and encrypted with a private key. Any attempt to modify the contents of an email will be noticed, and the email will be rejected. This server-level check is another weapon in the domain-spoofing defence arsenal. The pairing of these two records provides insight

into trustworthiness and confirmation the sender is who it is claiming to be.

Stepping up to DMARC

DMARC enters the authorised email equation by checking that your SPF and DKIM authentication records are a proper match and, critically, determining what happens to the email in question: whether it goes to your inbox, your spam folder or bounces right back to where it came from. This should be seen as protection for your domain, your brand and your trustworthiness, as it determines how emails that claim to be from you get dealt with if they fail the authentication process.

If your organisation or business is on the larger side, then DMARC is best left to those who specialise in such things, and there are plenty of DMARC providers out there who can offer such services. However, for the smaller business it's actually pretty easy, in the overall DNS records admin scheme of things, to do yourself or have your domain service provider implement for you. I'm assuming you'll be doing it yourself for the purposes of this guide, so what does that involve?

The best way of explaining is doing, and as I recently reviewed the entire process when I was setting up a custom domain in Proton Mail, **proton.me/support/custom-domain**, I'll use this as an example.

All the following changes take place in your domain provider's DNS console, where they're added as TXT records, starting with SPF. This is simply a string listing authorised mail server IP addresses and domain names.

v=spf1

This tells us that we're using SPF version 1, which is always the first tag in the record.

include:_spf.protonmail.ch_

This is used to keep an existing SPF record, as each domain can only have one such record. Otherwise, you'd use **ip4:** followed by the IP addresses authorised to send domain emails. Adding an **~all** modifier at the end of the record dictates other domains will be marked as insecure whereas -all disallows all other domains.

In this case, the record is:

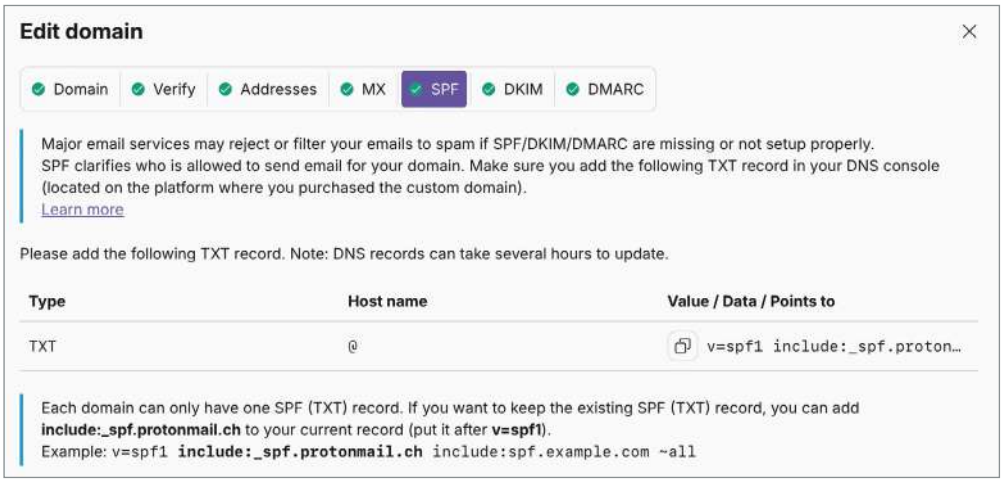
v=spf1 include:_spf.protonmail.ch ~all

You can refer to a full list of SPF mechanisms and modifiers at **tinyurl.com/359mechanisms**.

Moving on to DKIM next, these are entered as CNAME or TXT records in the DNS console. In the case of Proton Mail, a CNAME record points to the public encryption key, which makes things very straightforward, as you can see from the screenshot below left.

If you need to use a TXT record then things get a little more complicated, using a name format of **[selector] . domainkey [domain]**, where selector is a value for your domain that is issued by the service provider, and domain is the email domain itself. Various values can then be applied, with the required versioning bit of **v=DKIM1** starting the string. Other values include **k=**, which describes the encryption type, and **p=**, which holds the public key data.

Cloudflare has an excellent guide to DKIM which I recommend you get acquainted with if your provider doesn't adopt the CNAME entry route (**tinyurl.com/359cloudflare**).



ABOVE SPF is a string listing authorised mail server IP addresses and domain names

"The no-policy option is a real concern to security-minded folk as it's exploited by threat actors"

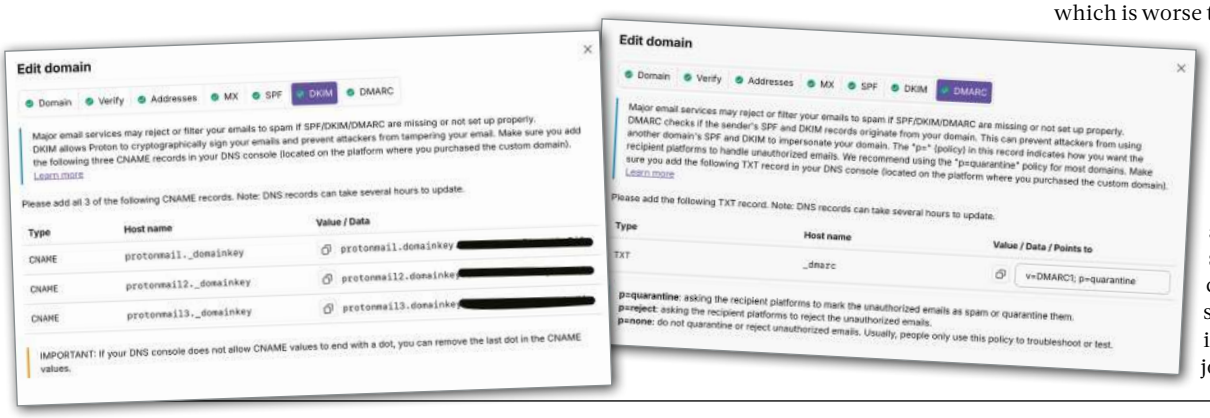
Tag team

This brings us to the DMARC entry itself. This essentially specifies the policy the recipient email server will apply, depending on the results of the SPF and DKIM controls, after checking the From field of the email in question. This TXT record starts with **v=DMARC1** to identify the version being used and then contains a number of tags.

Not all these tags are compulsory, but both **v=** and **p=** are. The **p=** tag refers to the DMARC policy itself and will instruct the mail server in receipt of the email whether a failure should be sent to the spam folder (**p=quarantine**) or bounced (**p=reject**). There is a third option of **p=none**, which indicates there is no policy and so nothing is done. The no-policy option is a real concern to security-minded folk as it's exploited by advanced threat actors in spear-phishing campaigns, which I'll address momentarily.

The other tags worth knowing concern the reporting mechanism of DMARC. The **rua** tag specifies the address where aggregate reporting data should be sent, while **ruf** is the same but for more detailed forensic data. When enabling the ruf option, you can use the **fo** tag to specify when it is sent: 0 for when both SPF and DKIM fail, 1 for when either fail. There's a good DMARC tag explainer at **tinyurl.com/359DMARCtags**.

I mentioned earlier that certain threat actors exploit poor email authentication policy implementation, which is worse than none at all. The Kimsuky group, also known as APT343, is associated with the North Korean military intelligence 63rd Research Centre and has been very active of late with spear-phishing campaigns targeting subject experts by impersonating journalists and



BELOW Getting to grips with DKIM (below left) and DMARC (below)

Continued from previous page

researchers. It has become such a problem that the Federal Bureau of Investigation, the National Security Agency and the US Department of State have issued a joint cybersecurity advisory on the matter (read it at **tinyurl.com/359advisory**).

The spying campaign crafts very believable emails directed at high-value targets. It then uses domain and sub-domain spoofing to add credibility to the messages by exploiting misconfigured email authentication settings. Kimsuky comes up with invented names for the journalist or expert concerned, but uses those legitimate domain names to fool victims into thinking it's a genuine communication. The advisory I mentioned recommends all email admins act immediately to ensure that their DMARC policies are properly configured, and for once I agree wholeheartedly with the spooks. So please be sure to check your DMARC policy is configured either to p=quarantine or p=reject.

Research from email security provider EasyDMARC has shown that the number of DMARC implementations among .org email domains, so often used by groups such as Kimsuky, has doubled in the past 12 months. That's the good news. Of the 9,935,024 verified .org domains analysed by the provider, DMARC implementation has grown from 3.98% to 7.78% in the year up to March 2024. That's the bad news. DMARC has been around for more than a decade now, yet still more than 92% of these non-profits have yet to use it.

While more than 50% of those who have got a DMARC policy are using the FBI-recommended settings, the numbers are disappointing. As Gerasim Hovhannisyan, EasyDMARC CEO, put it: "This research shows that action to implement DMARC among non-profits is well under way, with the number of domains with DMARC policies almost doubling in a year. On top of this, the domains implementing it are increasingly adopting more secure policies – which is unsurprising in the face of an ever-growing threat from phishing attacks. But clearly, there's still a long way to go with 92% of domains still unprotected."

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STEVE CASSIDY

"Thinking defensively doesn't just apply to hackers; it applies to the government and regulators, too"

Why older computers can be better at diagnosing problems, the challenge of forgotten file formats and war's effect on cryptocurrency trades

One of the few statistics that sticks in my head is that the average length of stay in a job in the UK is a shade over two years. Unfortunately, I can't find a source for this memory, and other research suggests it's closer to five years, but even so this means that the average worker has between ten and 20 different employers, assuming a 50-year working span.

Of course, not the whole workforce is going to be bang on the population average in any company, so one would be unsurprised by places and people that buck the trend. The stick-in-the-mind example for me was the lovely old chap who spent an entire lifespan in a single room, making twiddly parts for bicycles.

If I had met him after the last few days of bureaucratic trench warfare, I would probably have asked to see his P60 or P45, no doubt beautifully inscribed in ageless, glitteringly black ink on vellum, spattered with various dates in 1962. It turns out these two forms of information about employment history are some of our most durable and important records – for government, at least. Even in the days of the paper P45, I can remember the sense of hollow-bowelled terror that came with not being able to find one or the other at 3am on the day of the job interview.

So I was somewhat puzzled by a distressed call from a friend with an older Mac laptop. She was in just the circumstances I remember, of being challenged for her P45 as part of the recruitment process; only now, things are different. The former reliance on paper has shifted over to various online document formats, and a password that's based on your National Insurance number.

I realise that this is in line with current procedures, encouragingly underpinned by a mostly public and eternally supported file format, but I still couldn't get the idea of how this delivery mechanism would fare when it hits people like me. I've had maybe four full-time jobs in my career. My panic about P60 forms comes along roughly every seven to 15 years. Would I be capable of remembering a password like this, over a timescale like that?

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"My panic about P60 forms comes along roughly every seven to 15 years"

To be scrupulously fair, most of my passwords are even older than that, having been generated on a minicomputer some time in the early 1990s. The reason I remember those is that I use them almost every day. Having a separate password for a vital bureaucratic knick-knack, which is only needed twice per decade, is a recipe for disaster.

Then there's the software issue. Find a file from 20+ years ago for any platform you care to use; can you open it on your newest computer? If not, what's your next move? My favourite example here is Word 2.0 documents. I wrote a lot of pieces in Word 2.0: it wasn't until 2019 that I discovered just how many modern word processors had decided the Word 2.0 file format is now *infra dig* (that is, beneath the dignity of today's software). The fact remains that long-term retention of security access methods is not something the IT sector has done terribly well with.

BELOW **Accessing old P60 and P45 forms is now done digitally**

Personally, the next time I contemplate a change of career, I shall look back through my traditional collection of accordion files, with each alphabetised pocket holding a slim plastic folder in which resides an amalgam of modern slimline USB storage keys and paper copies of the important files found on those CDs. This is in case Bad Things befall my filing cabinet.

I don't think the current mix of tools or procedures found inside HMG will stand the test of time for the next 20 years. For one thing, Adobe has a commercial interest and a profit motive in adding new stuff, and for another the spread of personal identities within a blossoming variety of government departments and quangos will lead HMG into presenting projects both good and bad, aiming to "simplify the workload of the average user in 2035".

I don't suggest any protest marches on this subject. It's just a no-alternative decision made by a designer somewhere deep in the bowels of something, which we can expect to either work out just fine, or be a complete nightmare and get torn out in a few months' time. What I am hoping is that you'll get the idea that thinking defensively doesn't just apply to classic hackers; it applies to the government and its regulators, too.

Cryptocurrency downs and ups

An 88% drop in anything is worth your attention, I think. Whether it's the cost of an ice cream sundae or the fuel consumption of one of Elon Musk's rockets, 88% is an attention-seeking number. In this case, the 88% drop was in the volume of cryptocurrency trades over the first three months of 2024, according to one of an apparent gazillion cryptocurrency trendspotting and opinion-generating sites. Back in 2021, peak daily trade volumes hit $500 billion, while the highest figure this year was $329 billion. And this May, one day fell to $39 billion in trades, which is where the 88% headline figure comes from.

Casual observers of cryptocurrency and its delights will no doubt argue that market volumes are irrelevant. Just like traditional currencies, cryptocurrencies are discussed in the financial press mostly on their per-unit pricing. This gives us the persistent presentation of the euro to sterling conversion rate of roughly 1.2. This is painfully embarrassing as a public comparison measure if you're a proper dealing-room international banker, with red braces and everything, because at that level they actually buy and sell lumps of cash. No purchase is made without a buyer waiting to take it, no sale without some stock to draw on to cover their position. I can describe this environment with some sense of authority because my first real paid job was at a merchant bank, and it had a trading floor. This appears to put me way out front of a lot of cryptocurrency traders.

When you read about a "sterling crisis" in mainstream blogs and papers next time, dig deeper. Is it in fact because the recent trading volumes have been very low? That makes the unit price (everyone outside the biz calls it the "exchange rate") very susceptible to influence coming from very small groups of traders, because their war chest reserves are comparatively large when contrasted with the volume of money transacted in that particular currency. So, to get a good idea of what's going on in a market, you must include the very statistic that most of the regular press leave out: that trading volume number.

With all that said, you may be asking what a four-times reduction in daily trades in crypto actually means. To which I reply, well, we are at war, you know.

Those speculators and government assets that dabble in crypto exchanges are finding their hands rather full, with not just one but two extremely superpower-sensitive conflicts in progress. Russia is prohibited from transacting with most of the rest of the world; so is Hamas.

ABOVE The drop in cryptocurrency trades has been steep

"The first quarter of 2024 has not been kind to amateur traders in crypto"

BELOW Amateur crypto traders can't compete with the big players

It's a big jump from those simple statements of fact to an entire marketplace's behaviour, but I suspect what's been happening is a mixture of two fairly mundane action plans. The first one is that big players with deep pockets have been relatively recent entries into the crypto marketplace. Where it was once just a bunch of hobbyists, fiddling around with farms of servers, the impact of market forces was comparatively light. However, once a war starts, all bets are off, and quite a lot of the participants in these markets are betting people at heart.

The first quarter of 2024 has not been kind to those amateur traders in cryptocurrency. In the case presented accounting for the 88% drop in trading, the assertion is that most holders of crypto aren't happy to trade in a market so apparently doomed by actors whose resources far exceed even the most enthusiastic hobbyist. So they hold on to their coins, untempted by each day's rate or volume statistics. We end up with a stalemated marketplace, unable even to support the kind of universally beneficial transactions we were told would be made so much easier by cryptocurrency services.

I know that earlier versions of BTC managed to come back from the brink before, but really, when only one-fifth of the value some people bought into with real currency from their non-crypto resources remains in their accounts, I find myself asking: was all that fuss really worth it?

Small and perfectly formed

As regular readers will know, I have an obsession with mini PCs. These little machines are where the cleverest engineering is to be found, and when

someone wants to know why a big PC doesn't seem all that fast, I always try to get them to switch to an almost impossibly small machine and repeat their experiments. Small machines expose peculiar behaviours so much faster than a nice, roomy, memory-stuffed server box will.

I have several exceedingly low-spec but not terribly old machines here I use for this kind of system testing. In particular, I'm thinking of an HP X2 detachable, an early 2-in-1 tablet which fields only an Atom x5-Z8350 CPU, 2GB of memory and a thoroughly outdated 32GB MMC disk for storage. Equipped with a touchscreen, this x2 is mainly responsible for making me look like an idiot in public when I travel with other computers, because it has an excellent, pin-sharp, super-bright screen and I get used to poking that and sliding things around rather too much. No fool like the old fool caught using a non-touchscreen laptop!

Anyway, the burden of Windows 10 updates has become fierce in the run-up to newer version releases coming along, and the X2 has started to show the symptoms I originally took about a month of inattentive clicking to try to resolve. Those issues all coming together make me think I'd better restate the truths that keep this little old tablet useful and responsive, some six years after it was the latest gadget.

Most of this is all about free space on your C drive. You can use all sorts of different tools and utilities to take a look at the distribution of data and executables on the drive – Microsoft technical materials persistently use the AOMEI partition tool as their choice for a walkthrough, even though most of its features aren't anchored by a common connection to "partitions" at all. Feel free to trawl around the Microsoft support pages looking for a general guide to this issue, though I have to say you may come out after quite a long period no wiser than you went in; they don't hold back when it comes to deep dives into Registry keys, third-party utilities, irreversible admin-level command line utilities and even the occasional PowerShell script.

ABOVE The venerable HP X2 I use for testing is struggling with Windows 10 updates

You can fix the issue of full C drives blocking the delivery of important OS updates without any of those more complex, data-centre-level solutions. The reason your updates won't finish downloading is that almost every sector of your C drive has, at one time or another, had part of a file in it. When you or the operating system deletes that file, the sector it occupied is marked as "free" – but that's in the partition table, not in the actual little square-ish blob of disk space. All the contents of your deleted file are left there, unless you explicitly choose to scrub them out. This is so that any attempt to recover a deleted file has a reasonably high likelihood of success. Ultimately, Windows will re-use that sector, but only after making exhaustive searches of the rest of the drive for actual empty unused space.

With the general run of user files (Word documents, Zip files, pictures), this is an excellent strategy. You want those occasional undeletes to run smoothly, after all, and your updates proceed in the background anyway, with hardly a usable error message to show, so where's the fire here? This is where my little X2 comes in handy. It can easily demonstrate what happens when update packages arrive, expecting to be unpacked in a largely random pattern across your free disk space – except when the "free" sectors have deleted file patterns preserved inside them.

"Even as we get closer to Windows 12, lessons learned as long ago as Windows 7 are still important"

The answer, on machines big or small, is to run a utility that writes zeros into every free sector. This is easy for me to demonstrate on the x2 because it doesn't have more than a few thousand qualifying sectors! Not so simple to give a good demo with the Yoga 7 Slim I'm writing this on, with its 1TB, 90% empty hard disk. Some of those taking my suggestions as gospel report zero-fill utility runtimes that need a good Spring Bank Holiday break to complete.

Zero-fill is only one of the stages of this process, mind you. You have to defragment all the simple files living their best life on the C drive, to shake all the zero'ed sectors out into a single and side-by-side parade of available sectors, and if that defrag takes another long weekend then (1) you're in need of a massive clearout, and (2) none of your other "good housekeeping" utilities have actually helped one tiny bit.

Running this sequence of actions on the X2 takes a couple of hours after a large feature update has been announced. I admit, it is blatant cheating to show this to the unconvinced company network manager, because the chances are that his faster, newer, even multi-user machine will not complete the self-same sweeps and zero-writing anything like as quickly. The lesson learned is hopefully clear: even as we get closer to Windows 12, lessons learned as long ago as Windows 7 are still important.

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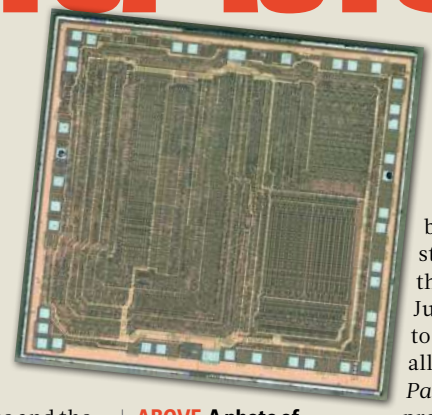
BELOW My Yoga 7 Slim has a 1TB hard disk that's 90% empty

Chip off the old block

Standalone sales of the Z80 CPU have finally been discontinued after 48 years. David Crookes looks back on a chip with a staggering impact

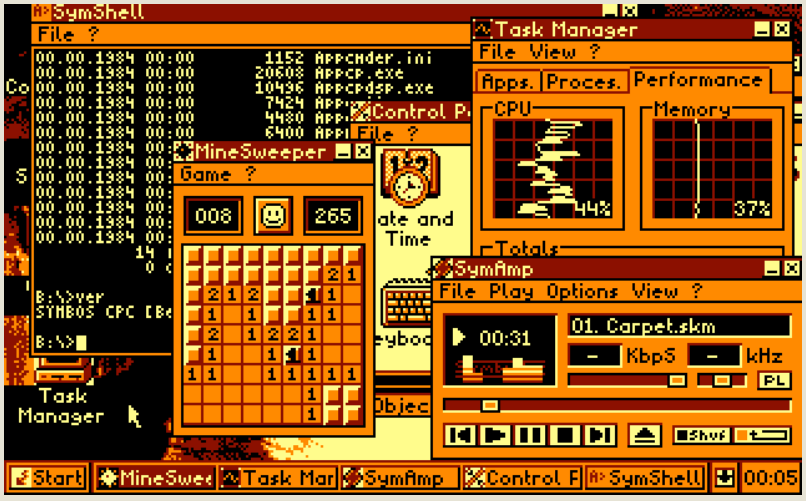


ABOVE **A photo of the layout of the original Z80 microprocessor**

When you consider the list of machines that have made use of Zilog's Z80 microprocessor chip, it reads like a computing equivalent of Who's Who. Having burst onto the tech scene on the back of a 1976 advert that pitted the Z80 squarely against Intel's 8080A in a so-called "Battle of the 80s", Zilog's single chip ended up being used in Sinclair's ZX80, ZX81 and ZX Spectrum, Amstrad's CPC and PCW ranges, the TRS-80, the Osborne-1, a host of early Sega consoles and many more machines besides.

You'll find it in the Amstrad NC-100 and NC-200, the TRS-800 Model 100 and Sinclair's Cambridge Z88. You'll spot it inside graphing calculators made by Texas Instruments and Amstrad's ill-fated E-mailer telephone. There was a Zilog Z80 chip inside the Commodore 128, which allowed it to run the operating system CP/M. This OS came to be very closely associated with the Z80 and it meant gems such as the database management program dBase and the word processor WordStar could be used across platforms.

The Z80 chip has also powered lots of obscure computers, from the Mattel Aquarius to the Dick Smith Super-80. In fact, it was so widely used that practically anyone growing up in the 1970s, 1980s and even 1990s would have been in contact with a Z80-based machine at some point. And if they weren't, then perhaps they got to grips with a computer that contained a compatible clone. There were plenty of those, too.



LEFT **SymbOS is an operating system specifically designed to run on Z80-based 8-bit computers.**

With all that in mind, it's been sad to learn that Zilog stopped accepting orders for the standalone Z80 CPU on 14 June this year, putting an end to 48 years of production. After all, the chip that powered the *Pac-Man* arcade game has proven perfect for devices which haven't needed immense amounts of power. And, while Zilog is going to continue manufacturing the eZ80 8-bit microprocessor introduced in 2001 as an updated version of the Z80, it still feels as if the tissues need to be brought out in mourning for an old, departed friend.

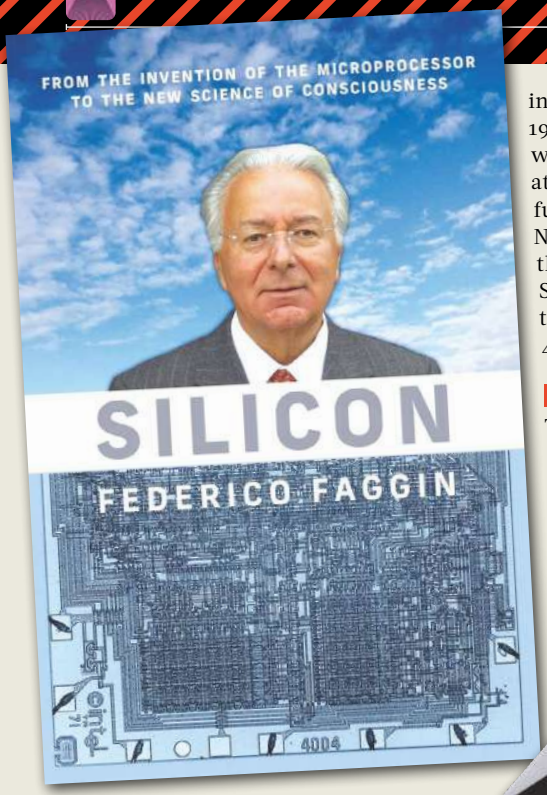
"The Z80 was significant – you got a lot of bang for your buck," explained legendary programmer Paul Hughes, who has coded commercial games since he was 13 years old and has worked on many Z80 systems since.

"Anyone growing up in the 1970s, 1980s and even 1990s would have been in contact with a Z80-based machine at some point"

"It was so cheap, it was even used as a co-processor in some console and arcade hardware. The Sega Mega Drive's main processor was a 68000 variant, for example, but it also carried a Z80 purely to deal with the audio side of things, taking that burden off the 68000."

Born zippy

Development of the Z80 emerged following an unsettled period at Intel, a company that, having formed in 1968, had quickly achieved success with the 3101 bipolar SRAM. Intel had employed Italian-American physicist and engineer Federico Faggin, who



LEFT *Silicon*, Federico Faggin's autobiography, is well worth reading

Credit: Evan-Amos, Wikimedia Commons

developed self-aligned metal-oxide-semiconductor silicon gate technology at Fairchild. Faggin would go on to design the first commercial microprocessor, 1971's Intel 4004, and he led a team to create the Intel 8008 and 8080 8-bit microprocessors.

Despite his success, however, Faggin didn't feel his employer was fully invested in microprocessor development and that it really wanted to continue with its primary business: the sale of RAM and ROM chips. "It soon became clear that top management was not taking the custom circuit business seriously," Faggin would later write in his autobiography, *Silicon: From the Invention of the Microprocessor to the New Science of Consciousness*. "They had no intention of making the necessary investments to turn that secondary activity into a meaningful business. Moreover, Intel was not cost-competitive with the best suppliers in that market."

In 1974, as the US economy was plunged into a recession triggered by the 1973 oil crisis, Intel began making redundancies. Faggin was getting tired of fighting for what he felt was important and he left on 31 October. Engineer Ralph Ungermann, who'd joined Intel in 1971 under Faggin's supervision, also departed, and the pair decided to form their own company.

Such was their standing in the industry their departure was covered in the weekly trade newspaper *Electronic News*, and the report on the new company proved to be a pivotal moment. Executives at Exxon Enterprises, the investment arm of the multinational oil and gas giant, had read the news and told Faggin and Ungermann of their wish to invest in the new endeavour. In June 1975, the pair's tech company – which didn't even have a name at this point – was handed funding to the tune of $500,000. Now on a firm financial footing, they were able to hire Masatoshi Shima, the principal logic and transistor-level designer of the 4004 and 8080.

Setting traps

The initial idea was to create a single-chip computer called the 2001 containing a high-speed CPU optimised for I/O operations. It would, Faggin said, have a host of programmable I/O ports and sufficient ROM and RAM. With $500,000 in the bank, the new company reckoned it could create a working chip and a development system with basic software.

BELOW A Z80A powered the Sega Master System and the handheld Game Gear

Work began at their base in downtown Los Altos, but doubts began to set in. The plan was to contract the early wafer production to Synertek and set up an in-house wafer fab once the company had become established, but Faggin couldn't get the sums to add up. Instead, he proposed the Super-80 CPU, which would be twice as fast as the 8080, contain an interrupt structure on a par with the best minicomputers of the day and be machine-code-compatible with the 8080. This, Faggin wrote in his book, "would have a much higher profit margin".

To succeed, the company recognised the need for a second-source – a company willing to license the rights to fabricate the company's proposed chip, thereby giving customers more confidence in adopting the product knowing they weren't having to solely rely on a startup to fulfil their needs. While such a source was sought, Faggin and Shima got on with the task of working on what would become the Z80 chip, promptly completing the CPU architecture. By this stage, there were 11 people working at the company and the firm became known as Zilog, which was a play on "integrated logic".

Work proved tough. "Shima concentrated on the logic and circuit design of the CPU, and I concentrated on updating the design methodology with the new N-Channel MOS process with depletion loads that had not been used before for random logic, an area that was my speciality," Faggin wrote. "I developed a set of layout design rules that were relaxed enough so that the chip could be fabricated by any state-of-the-art factory."

Faggin reports working 80 hours a week and he hand-drew the layout of the Z80-CPU, revising his work midway through in a bid to squeeze everything in. As he explains in his book, a CPU simulator that used low-power TTL logic and wire-wrap boards was assembled and the Super-80 logic design was translated into TTL building blocks. "The primary purpose of the simulator was to enable the parallel design of the hardware and software of the development system alongside the chip," Faggin wrote.

The Z80 chip ended up featuring about 10,000 transistors and it ran at a speed of 2.5MHz, higher than the 8080. It also included a built-in DRAM refresh controller and an extended instruction set.

"It was a shrewd move that paid off handsomely, and it allowed Zilog to steal a march on the market"

"The Z80 had lots of registers (or certainly lots in comparison to, say, 6502) and moving data around registers is much faster than having to work in RAM," said Hughes. "But for me the killer feature was the stack. You could point it to anywhere in memory and then 'PUSH' data to it 16 bits at a time with a single instruction, which led to blazingly fast memory clears and sprite plotting routines."

Zilog also created a barebones operating system with a word processor, assembler and debugger. But to be truly successful with the Z80 (the idea was to create five initial chips: the Z80-CPU, Z80-PIO, Z80-CTC, Z80-SIO and Z80-DMA), Faggin knew Zilog needed to head off any threats from competitors seeking to clone its chip.

At that time, it was common for companies to create copycat versions of new technology – especially in Japan, Eastern Europe and the Soviet Union – so Faggin and Shima incorporated seven traps in their design that were, Faggin said,

BELOW One of the very early Z80-CPU chips, which was sold in June 1976

Credit: Damicatz, Wikimedia Commons, CC BY 2.5

"impossible to spot optically". One of them would sever the link between the internal and external bus, and the hope was that it would take engineers a sufficiently long time – half a year or so – to effectively reverse-engineer and manufacture the chip. It was a shrewd move that paid off handsomely, and it allowed Zilog to steal a march on the market.

Quick success

The Z80 went on sale in July 1976 having been launched in May, and the two-page "Battle of the 80s" advert in *Electronic News* proved effective. Cromemco (a Californian company that created the Z80-based S-100 bus computers) was first in the queue, followed by NEC – one of the firms that did indeed try to copy the chip, finally launching a clone two years later.

Such was the Z80's early success, Zilog began to quickly expand. It created its own wafer fab, opened up more office space and negotiated second-source licences, striking a deal with Mostek that created a Z80-compatible chip called the MK3880.

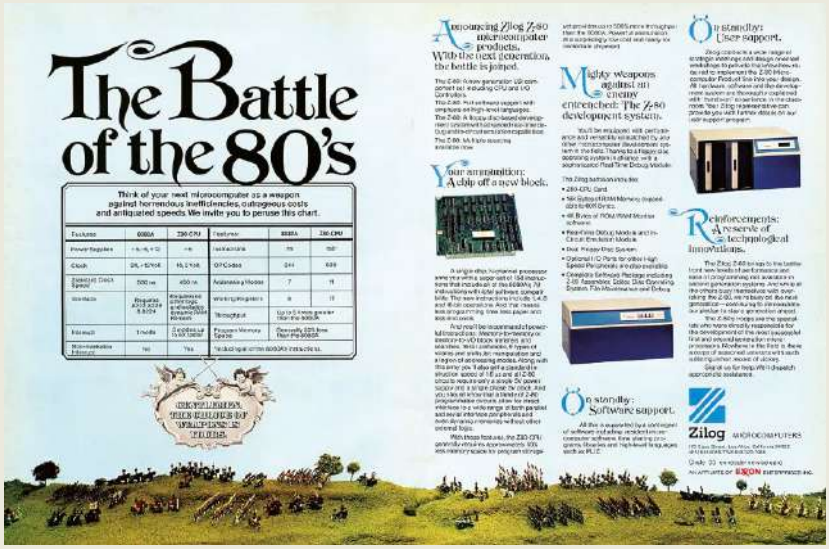
Zilog manufactured its own Z80 chip in January 1977, and the company didn't look back: it ended up having two wafer fabs, a system manufacturing plant and a chip assembly plant within three years. It also employed 1,100 workers by 1979 and saw the Z80 become more popular than the 8080 – a major triumph and cause for celebration at Zilog. The Z80 ended up going head to head with MOS Technology's 6502, which had launched in 1975.

Faggin stepped down as president and CEO in 1980 when Zilog became a subsidiary of Exxon. But the fact that the Z80 remained popular into the 1980s was testament to both its excellence and large take-up among technology companies.

Many developers grew to know and understand the chip, making production of hardware easier and quicker in many cases. According to Roland Perry, Amstrad's technical manager, "the bonus was that my hardware contractors were familiar with it and, due to things such as the memory refresh, it made for a cleaner, simpler design."

Having computers based around a Z80 chip had software advantages, too, which served to drive the market for the chip even further. "The Z80 was used for the Amstrad CPC 464 because it was required for the only BASIC available to me within the necessary timescale," said Roland. "What we couldn't have predicted at the time, though, was the CPC 6128, which although created as a marketing 'numbers games' needing more than 64K of RAM, enabled CP/M. It rather quickly became perceived as just as much a small-business computer as a games machine, which increased the market considerably.

"It meant that when the PCW came out there was already a library of CP/M software on three-inch disks. As a result, Schneider in Germany marketed the PCW mainly as a business computer rather than a dedicated word processor, which was a bit-off message as far as Amstrad was concerned."



ABOVE Zilog ran an advert in May 1976 comparing its new Z80-CPU with Intel's 8080A

Back to the future

Despite the Z80's large impact, Zilog's influence on the computer market wasn't to last. Intel eventually got its act together and took the development of microprocessors seriously, which meant it powered ahead and became the dominant manufacturer, despite Zilog's foray into 16-bit and 32-chips. One consequence of this was Zilog's growing concentration on microcontrollers (it launched the Zilog Z8 microcontroller in 1978, which integrated a CPU, RAM, ROM and I/O facilities). Yet demand for the DIP-packaged Z80 CPU models continued.

Hobbyists still use the chip to create their own Z80-based computers – there's a modular machine called the RC2014 that has proven popular, coming in kit form with parts that customers need to solder together. The availability of Z80 chips has also meant that some broken retro computers can be repaired, and the Z80 can still be used to tap into nostalgia. The ZX Spectrum Next – which has had two releases, one in 2020 and the other in 2023 – has the Z80 implemented in a field-programmable gate array (FPGA). It provides a perfect representation of the chip.

"Working on games for the ZX Spectrum Next has reminded me of what a nice little processor the Z80 was," said Hughes. "And although a lot of the 'moving the data around with the stack' is ameliorated by the Spectrum Next's direct memory access (DMA), there's still a bunch of flexible instructions with a chunk of registers to juggle your data around with."

"The fact that the Z80 remained popular into the 1980s was testament to its excellence and large take-up among tech firms"

Projects such as this means that development around the Z80 is set to continue. There are lots of reasons to be excited, such as the ongoing support for the SymbOS multitasking operating system that's been created for Z80-based computers such as the CPC, PCW, MSX and Enterprise 64/128. As for Zilog itself, it's still going strong, showing how, over the past 48 years, it's managed to forge a place within the industry. More than that, though, it's taken a firm place within many a computer user's heart.

BELOW The Z80 sat alongside the MOS 8502 in a Commodore 128

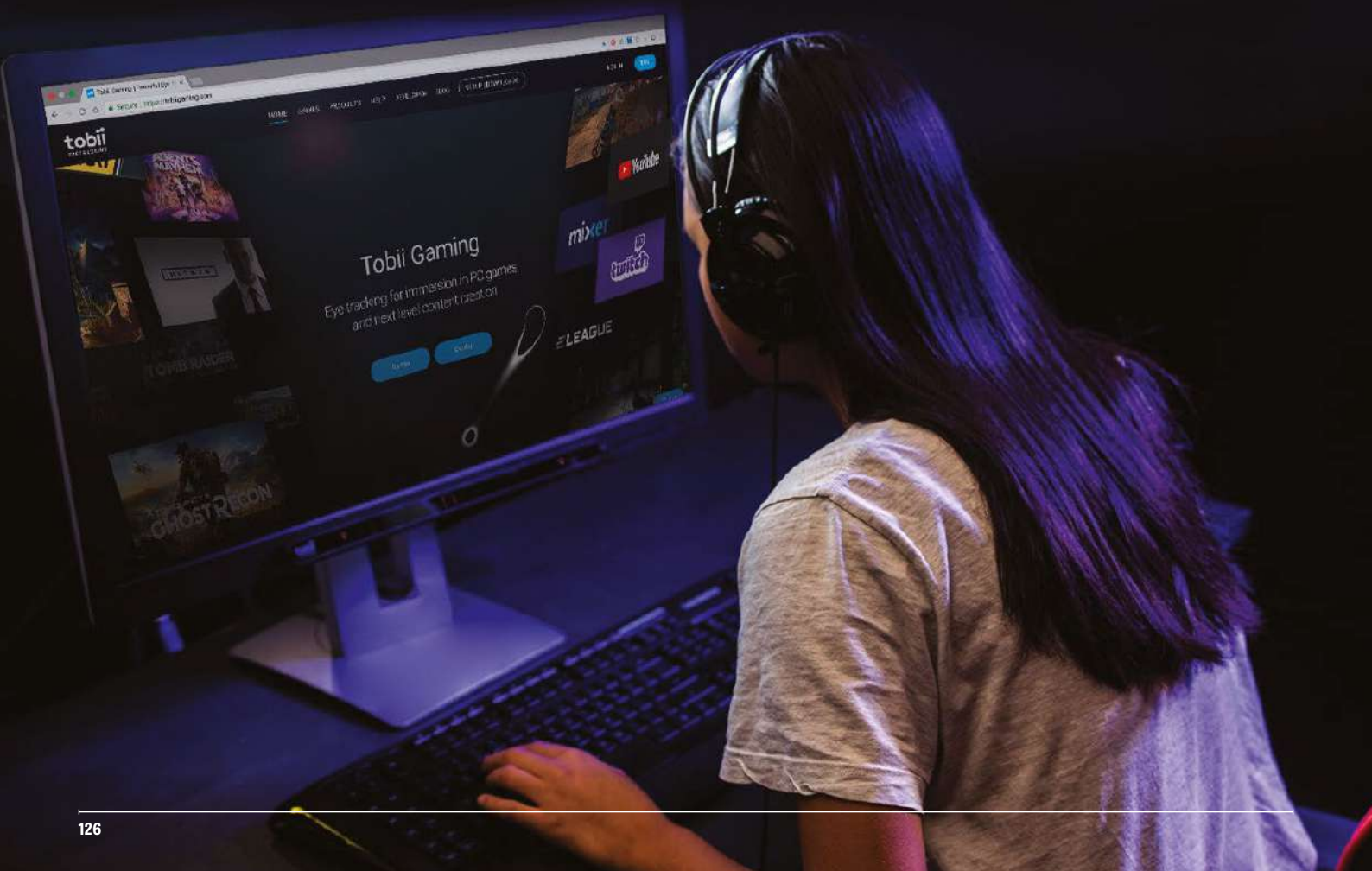
Credit: Evan-Amos, Wikimedia Commons

Futures

We explore the trends and technologies that are set to shape the future

Control your computer with your face and head – it's the future!

As if to show nothing is new in the world of technology, eye tracking and gesture control date back decades. But if Apple's on board, maybe their time has finally come, suggests Nicole Kobie



Forget typing and mousing. We've been trying for years to come up with new ways to interface with computers, be it eye-trackers, mind-reading tech or VR-powered immersive systems. And among *PC Pro* staff (past and present), it's become a joke. We once even ran this headline: "Control your computer with your face and head!"

Yet here I am, typing into a laptop and staring into a monitor, just like a chump from the 1980s. But perhaps not for much longer if Apple and Google have their way, with announcements on eye-tracking plus head and face movement recognition.

Such technologies were created for people with accessibility challenges, and that's also the origin of eye trackers and brain-computer interfaces (BCI). Hopefully, by integrating such accessibility tools into mainstream tech, iPads and other computing devices will be easier for everyone to use – even if the rest of us are still tapping around the display.

Eyes on the prize

In May, Apple announced that eye-tracking technologies would be among a range of accessibility features coming to iPads and iPhones this year. Eye Tracking, as Apple cleverly calls it, will be built into the devices, powered by on-device machine learning, and using a front-facing camera. After a quick calibration, users can navigate iOS and apps with just a look, using a feature called Dwell Control.

Eye-tracking tech has been in development for more than a century. Researchers first began trying to track eye movements in the 1870s as part of studies hoping to better understand how we read. By the end of the 1890s, a researcher called Edmund Huey had test subjects wear special contact lenses with an embedded aluminium indicator to track movement – though it was so uncomfortable enough that he apparently gave subjects cocaine to tolerate his studies.

In the 1920s, work began using video recordings to study eye movements, while in the 1940s researchers used photography to study pilots' eye movements to understand how they use their flight instruments; the work was used to reorganise cockpits for ease of use. Headsets were introduced in the next decade by Alfred Yarbus, a Russian psychologist, to track how study participants looked at complex images, and were subsequently used to aid user interface designs, with early computers used to power eye-tracking studies by the US military in the 1960s and 70s, predominantly focusing on ways to improve flight controls for military pilots.

By the 1980s, eye trackers were applied to computing devices to study how to better design interfaces by considering how long eyes were fixed in any one place, the path they scanned and so on. In 1981, one study examined how easily students could read text on a CRT display with different scroll rates, while subsequent studies considered menu design. In the 1990s, that work expanded to UI and UX for web pages. In 2008, researchers at McGill University in Montreal even designed a game that watched players' eyes to put villains where they were least likely to look, and later attempts to use gaze tracking for advertising were met with ethical concerns.

While that's all interesting – and such ideas are still used to improve designs – it's still not controlling a computer with your face and head.

Take a look

At a 1992 tech conference, Dixon Technologies showed off an eye-tracking system, EyeGaze, that could control a PC cursor. An LED was beamed into the eyes, and the resulting reflections were tracked by a video camera. The data was analysed using bespoke software. A decade later, in 2002, Imperial London researchers unveiled an eye tracker that they predicted wouldn't necessarily fully replace the mouse, but would be added to our repertoire of input techniques.

And for some, they have. For that, we turn to Tobii. Founded in 2001 in a Swedish garage – not even Nordic startups can avoid that cliché – Tobii's first product was a tracker that could plug into a PC. With three sensors along the top and a bodged-together collection of components on the bottom, it was widely used by researchers. Tobii uses pupil centre corneal reflection, which essentially shines a light into the eye to track the pupil's position to figure out where someone is looking.

Four years later, Tobii released an eye-controlled computer, its first foray into assistive technologies to let those with disabilities interact digitally. In 2014, it unveiled the "EyeChip," a platform created to be integrated into consumer products, such as gaming devices. Indeed, hundreds of PC games support the standalone Tobii Eye Tracker.

In short, you can already control your PC with your eyes; you just need to buy the proper hardware. Beyond Tobii, there are plenty of alternatives, especially in the assistive market. Irisbond's technology is used for communication and to diagnose disease, and let people avoid touching surfaces to prevent infection. Other companies, such as Mirametrix (now a division of Lattice Software), are using eye tracking for attention sensing, such as to prevent distracted driving, while Eyeware's Beam is used for gaming, automotive research and more, and only requires a webcam.

"Eye-tracking has been in development for more than a century. Researchers first began trying to track eye movements in the 1870s"

And amid the Zoom call burnout of the pandemic, researchers at the University of California unveiled a machine-learning system that tracks eye movements for better-quality video calls.

So don't imagine that eye trackers will replace, or even sit alongside, the humble mouse and keyboard for most people when it comes to computing input – they've been in the works for decades without that happening, after all. Instead, such systems have long been used to assist people with disabilities in communicating via computers and, more recently, to make games more immersive. In the longer run, expect these ideas to find utility in in-car systems and other places where touchless controls are helpful. It works; we're just really used to a mouse and keyboard.

Credit: Tobii AB

ABOVE **The Tobii Eye Tracker is supported by hundreds of games**

Get your Gameface on

In 2023, Google unveiled Project Gameface, a hands-free gaming "mouse" that can be controlled by facial gestures and

BELOW **Lenovo has worked with Mirametrix to create computers that track users' eye movements**

head movements – raise your eyebrows to click, open your mouth to move the cursor, for example – by using your device's camera to track motion and analyse it for navigation.

A year later, Gameface arrived on Android, with Google releasing more open-source code to allow developers to build it into their games and more widely into Android.

"Based on the positive feedback on Project Gameface, we realised that developers and users appreciated the idea of moving a cursor with head movement and taking actions through facial expressions," Google's Avneet Singh and Glenn Cameron said in a blog post. "We have replicated the same idea to bring a new virtual cursor on an Android device."

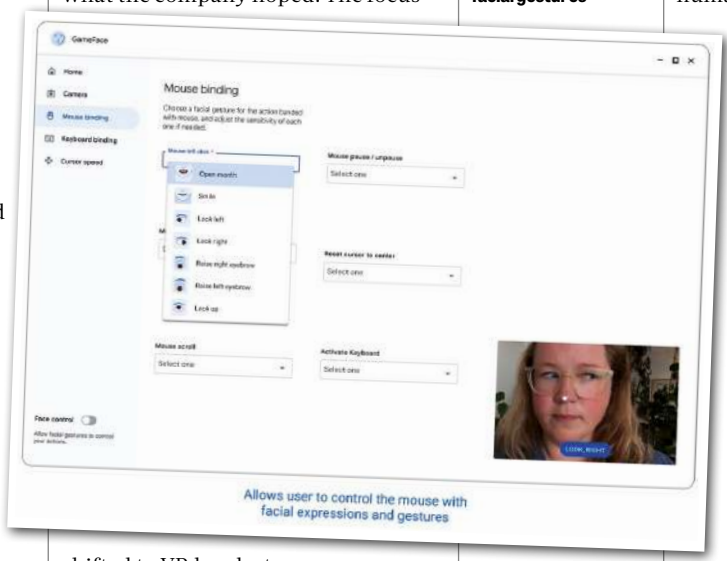
The idea of using facial and head movements to control a computer isn't new and stemmed from early eye-tracking systems – indeed, the two are often connected. Use cases beyond assistive technologies are few and far between, though in 2008 a student at the University of California created a video playback system connected to facial controls; look confused, and the pace slows down or pauses. The system also considered how often you blinked as a sign of not understanding or boredom. When it comes to assistive technologies, the advent of multiple cameras on devices has helped them become built in by default. In 2021, Apple introduced the wonderfully named "head pointer" on Macs, after offering a similar system on iPads. This uses the built-in cameras to track the movement of the face and head for those who can't use a mouse or trackpad.

Of course, there are other body parts you can wave around to get your computer's attention: your hands. In 2006, the Nintendo Wii had a version of gesture recognition thanks to the Wii Remote, allowing for motion detection to enable more physical, immersive gaming. Microsoft used infrared projectors and cameras for its controller-less motion-sensing Kinect, which was initially created for the Xbox One. While developed for gaming, the technology was eventually used in research, particularly robotics, and by businesses, with the launch of Kinect for Windows.

And then there's Leap Motion, a gesture recognition system for computing and games. First developed by David Holz in 2008 while he was a student, Leap Motion was founded in 2010 and made plenty of headlines – including in this very magazine – with bold promises and partnerships with PC companies, including deals to embed the technology into HP and Asus computers and keyboards.

The current Leap Motion controller uses infrared LEDs and dual cameras, feeding that data into software that models your hands down to bones and joints for accuracy. The Leap Motion Controller 2 can be used with various XR headsets for games and training.

However, it never really took off in a mainstream way; half a million devices were sold, but that was below what the company hoped. The focus shifted to VR headsets, and in 2019, the company was sold off to UltraHaptics, and the two companies re-emerged as UltraLeap. (Don't worry about founder Holz, though; he went on to found AI image generator Midjourney.)



BELOW Google's Project Gameface is a cursor controlled by facial gestures

In your head

And then there's BCI, or brain-computer interfaces. Why type with your fingers or move your eyebrows when you can simply think about what you'd like to write out? Jacques Vidal of (once again) the University of California is considered by many the father of the technique, having coined the term in 1973 and later implanting monkeys in 1987 and humans in 1998, allowing participants to control a cursor to escape a digital maze.

Since then, the technology has largely been used to address medical issues, such as paralysis or locked-in syndrome, in research settings. In 2004, one patient was implanted with a device known as a Utah Array, letting him control electronics such as the TV remote; in 2016, Stanford University researchers used the same type of implant to give a patient the ability to move a computer cursor to type; and in 2021, at the University of California, a paralysed man given an implant was able to type at 15 words a minute.

Such successes sparked the idea that soon we could ditch typing in favour of implant-powered brain control. Indeed, in 2017, Facebook founder Mark Zuckerberg revealed research to let us "type straight from your brain," partially to help enable augmented reality.

Facebook stopped that work shortly afterwards, but by then Elon Musk and a team of scientists had founded Neuralink, which this year implanted its first device into a human after years of, at times, controversial work with pigs and macaques. Again, the patient in this case was paralysed – Noland Arbaugh suffered loss of movement below his shoulders after leaping into a lake several years ago.

So far, the idea of implants to control computers remains one designed to help people suffering from disease or injury causing paralysis – as such technologies should. After all, the rest of us are doing just fine with typing, so everyone who requires assistance should get to queue-jump first. And BCI still requires major surgery, which naturally comes with risk.

What if we could control PCs without opening our skulls? Well, we can. IntendiX is one firm that uses EEG headsets to scan brain signals to direct computers, for medical purposes and gaming. It even holds hackathons to see how the devices could be used. Again, the idea isn't new: IntendiX has been showing off the technology for 25 years.

"The advent of virtual reality may herald a better way to interact with our PCs, or at least reduce our reliance on traditional UI tools"

In the end, those of us who can seem set on continuing to use keyboards and mice, aching wrists and sore hands be damned. The advent of virtual reality may herald a better way to interact with our PCs, or at least reduce our reliance on traditional UI tools, while head and eye tracking can boost immersion in gaming. But in the meantime, it seems unlikely we'll be controlling our computers with our faces or heads any time soon. ●

Order Nicole's book!

Why is dramatic future technology (such as smart cities – see p36!) always just around the corner, and never a reality? To find out, we suggest you buy Nicole's new book, *The Long History of the Future: Why Tomorrow's Tech Still Isn't Here*, which is now on sale. The hardcover edition costs £18.99 and the Kindle version is £13.29.

PC PRO Next month

ON SALE
Thursday 8 August

Features

30 YEARS ANNIVERSARY

30 greatest tech milestones ever
To mark our 30th anniversary, our contributors (and readers) pick out the 30 most significant products and events.

Features

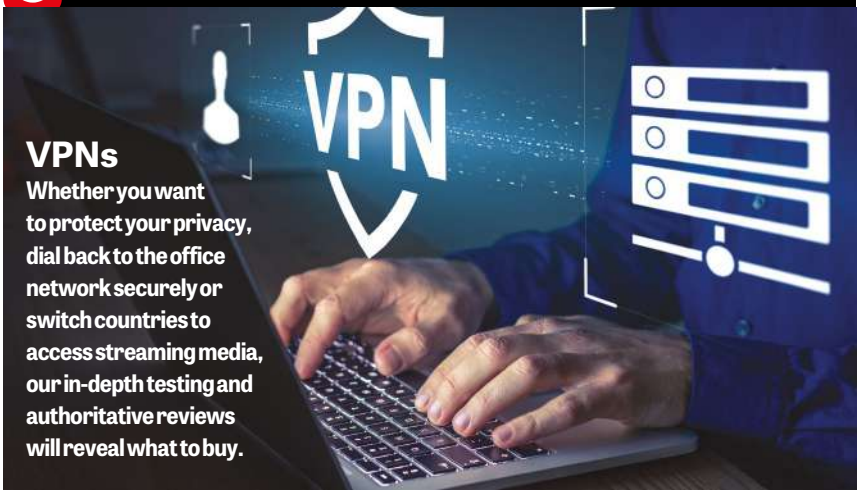
Keep your private messages private
We compare WhatsApp, iMessage, Telegram and other popular messaging platforms to find the smartest, safest ways to communicate.

Features

chromeOS Flex

Chrome OS Flex masterclass
Turn any spare PC into a snappy, secure Chromebook with Google's free web-based OS. Darien Graham-Smith shows you how.

Labs



VPNs
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Retro

Netscape Navigator turns 30
David Crookes remembers the rapid rise – and equally rapid fall – of Netscape Navigator, which finally prompted Microsoft to take notice of the World Wide Web.

The Network

Business protection
Cybercriminals are targeting smaller businesses more than ever before thanks to AI time-saving techniques. Here, we test products that promise to protect you from attack.

Futures

Battery boosters: thanks electric cars!
Love them or loathe them, the explosive (or hopefully not) growth or EV cars is also driving development of battery technology like never before. Nicole Kobie reports.

Dealing with a new firm? Jon Honeyball recommends you do your own digging

There is a website that I refer to every few days. It typifies government-run sites, because it is an infuriating mix of excellence, highly useful capabilities and annoying features.

I'm referring to the Companies House site. Whenever I'm taken to a site for a service I don't know which is processing information about me, I want to know where the company is based and what's behind it.

This morning, I received an email about a scan I'm having at Royal Papworth Hospital in Cambridge, part of Addenbrooke's Hospital. Nothing of concern there: it's an NHS appointment made through my GP. To access the letter of instructions, telling me where and when to attend, I had to visit a third-party website. This company provides IT services to the NHS and acts as a conduit for items such as referral letters and appointments.

Again, nothing to worry about. This is clearly an approved supplier to the NHS and is one that Addenbrooke's has contracted with for these services. Nevertheless, I went to the company's website to find out more. It's a well-laid-out site, with a modern look.

Then, almost immediately, I became annoyed. The Contact page has a form to fill out, but no physical address for this company. I had no idea whether it was based in London or Lithuania. Nor was there a company name for the site and service provider, just a brand name. I went to the Companies House website and looked up the name. I found nothing.

The next best place to look is the Privacy Policy on the company's website. Here I found a statement of its registered company name, company number and trading address. And from that I could then go back to Companies House, plug in the company number and have a root around. Fortunately, there was nothing of concern to see, so I made another cup of coffee and got on with other work.

Except for the nagging annoyance of a company not bothering to put clear contact information on its website. When said company is dealing with my health information, I'm more prickly about these oversights.

The Companies House website is, of course, a national treasure. Being able to pull up information about a business is extremely useful. So you might think all was roses there, no annoyance that might push up my blood pressure.

But no. You can register a company with ridiculous ease, as illustrated by an interesting thread on X about fake shell companies where one particular address in London was mentioned. You can see, in Street View, that it looks like a standard block of flats near Old Street. Nothing surprising there, except for the fact that over 300,000 entries on Companies House have used this address. Clearly there aren't 300K businesses working from there, so there must be some other explanation. And indeed there is: it's the address of a company registration business, which boasts that it has created over one million companies.

Another street I looked at hosts a vast raft of companies, most of which operate in the internet dropshipping category. Then I read the claim that these houses appear to be nothing to do with the companies registered, and that apparently you can register a company at any address and Companies House doesn't check to an appropriate level.

Is this the fault of the government department? Well, that depends on its remit. Companies House clearly states that it carries out "basic checks on documents received to make sure that they have been fully completed and signed, but we do not have the statutory power or capability to verify the accuracy of the information that companies send to us. The fact that the information has been placed on the public record should not be taken to indicate that Companies House has verified or validated it in any way."

So it will take in a registration and process it, and assuming it passes that limited checklist, your company will be registered. Companies House will, of course, handle complaints and issues, but these might not surface for a few years after registration. After which time, it's entirely possible that those of a less honourable persuasion will have done their dodgy business, and disappeared off into the sunset, only to create a whole bunch more.

> "Apparently you can register a company at any address and Companies House doesn't check to an appropriate level"

Should something be done about this? There are bigger problems for the government to tackle, but there are things you can do. First, check your own home address via the "Advanced company search" option, in the unlikely event that someone has registered a company to it. It's possible that something unpleasant might be found, and you can get onto Companies House to try to resolve the issue.

Second, do what I do. It should be part of your sleuthing when dealing with a new supplier or a new customer, or just because you're feeling nosy.

Not only is Jon Honeyball a contributing editor to *PC Pro*, he's also a registered UK trading entity. You can find him on Companies House or email jon@jonhoneyball.com

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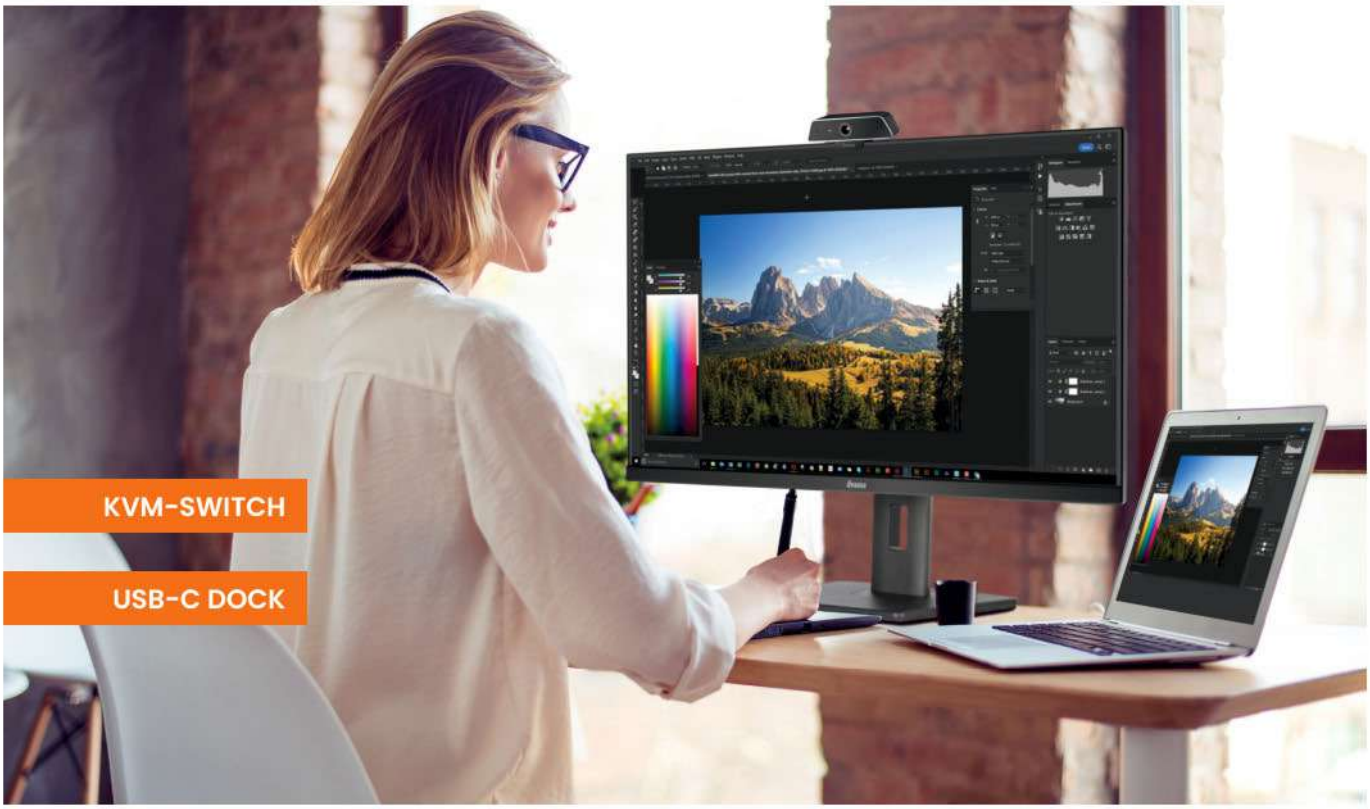

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